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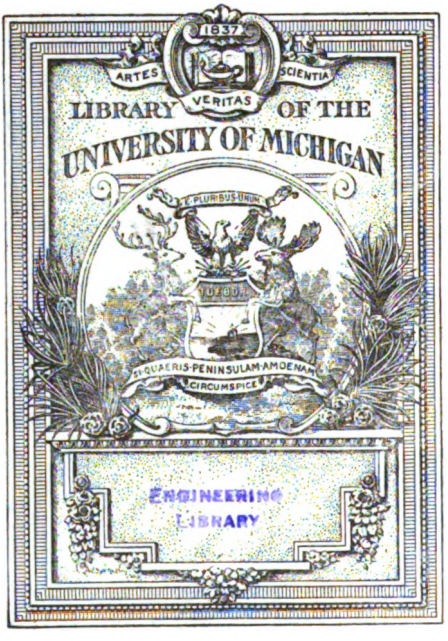

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50TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 1, pt. 2, vol. II.

ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY,

TO THE

SECRETARY OF WAR,

FOR

THE YEAR 1888.

IN FOUR PARTS.

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IMPROVEMENTS.—Monroe Harbor, Mich., 1981; Toledo Harbor, Ohio, 1983; Port Clinton Harbor, Ohio, 1986; Sandusky City Harbor, Ohio, 1988; Sandusky River, Ohio, 1996; Huron Harbor, Ohio, 1997; Vermillion Harbor, Ohio, 1998; Black River Harbor, Ohio, 1999; Rocky River, Ohio, 2001; Cleveland Harbor, Ohio, 2001; Fairport Harbor, Ohio, 2011; Ashtabula Harbor, Ohio, 2013; Conneaut Harbor, Ohio, 2015.

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C. B. COMSTOCK, Lieut. Col. of Engineers, Bvt. Brig. Gen. U. S. A. (*president* from April 10, 1888),
CHARLES R. SUTER, Lieut. Col. of Engineers, U. S. A.,
O. H. ERNST, Major of Engineers, U. S. A. (from May 15, 1888),
Mr. HENRY MITCHELL, U. S. Coast and Geodetic Survey,
Mr. B. M. HARROD, Civil Engineer,
Mr. S. W. FERGUSON, Civil Engineer,
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O. H. ERNST, Major of Engineers, U. S. A.,
Mr. G. C. BROADHEAD,
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Commissioners.

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[EXTRACT FROM THE ANNUAL REPORT OF THE SECRETARY OF WAR.]

WAR DEPARTMENT,
Washington City, November 30, 1888.

* * * * * * *

ENGINEER BUREAU.

The attention of Congress is again invited to the defenseless condition of our sea-coast and lake frontiers. The last appropriation for the permanent defenses of the country was made in 1875, and has long since been exhausted. The importance of immediate and liberal action looking to the effective defense of our principal sea-ports has been fully set forth in previous reports, especially in that of November 30, 1886. It would appear now more important than ever that such action should be taken at the second session of the present Congress in view of the fact that the last session gave appropriations for the construction of heavy ordnance. Without heavy platforms, strong armored protection, and other permanent emplacements, these guns and mortars when finished will be of comparatively little use.

The building of modern gun and mortar batteries requires longer periods of time than the construction of the armament. It would appear the part of wisdom that the preparation of these two important components of a well equipped defense should proceed simultaneously. For the beginning of the construction of such defenses an appropriation of $2,840,000 is asked for.

For the preservation and repair of the existing works, many of which are still of great value for secondary defense or as important parts of the contemplated new primary defense, no funds have been available since the appropriation of March 3, 1885. The consequent rapid and extensive deterioration is fully set forth in the report of the Chief of Engineers. For the preservation and repair of existing works $200,000 is requested.

Torpedoes and submarine mines are now acknowledged by all nations to be absolutely necessary to the efficient defense of harbors and seaports. For the purchase of these, and the necessary appliances for operating them, for experimenting to ascertain the best of the many torpedo inventions, and for the continuing of the construction of the necessary casemates, cable galleries, etc., for working the submarine

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mine and torpedo systems, $1,890,000 is recommended. A torpedo-shed for the storage of torpedo material for use in San Francisco Harbor, to cost about $22,000, should also be constructed.

The Engineer School of Application at Willets Point has continued its good work under many disadvantageous circumstances. General practical instruction to the younger engineer officers has been given, and several artillery officers have taken a special course in torpedo service. Attention is invited to the report of the Chief of Engineers on the subject of the post of Willets Point and the engineer depot and Engineer Battalion.

For the incidental expenses of the depot, for purchase and repair of instruments, the purchase of material for instruction, for the library, and for a model room, $20,000 is requested.

Rivers and harbors.—The river and harbor act passed during the second session of the Forty-ninth Congress failing to become a law, the works for the improvement of rivers and harbors have been prosecuted during the last fiscal year with funds derived from balances remaining on hand from the appropriations of the act of August 5, 1886, together with such few remnants of former appropriations as were available. In many instances, these being barely sufficient to provide for the care of the public property pertaining to the works, operations were necessarily suspended, to the great detriment of the improvements concerned. The report of the Chief of Engineers sets forth the condition of each improvement, the extent of the work performed during the past fiscal year, and the amount of money expended. In compliance with the provisions of the river and harbor act of March 2, 1867, estimates are presented of the amount that can be profitably expended during the fiscal year ending June 30, 1890, together with the probable cost of completion.

Such of the reports of examinations and surveys for improvements at places required and provided for in the river and harbor act of August 5, 1886, as were not inserted in the annual report of the Chief of Engineers for the fiscal year ending June 30, 1887, were separately transmitted to Congress during the present session as received.

A statement is given in the report of the Chief of Engineers of the action taken during the past fiscal year upon plans and locations of bridges proposed to be built over navigable waters under authority of Congress and subject to the approval of the Secretary of War. Examinations were also made, whenever requested by committees of Congress, of proposed bills authorizing the construction of bridges upon which the views of the War Department were desired. A statement is also given of the work accomplished in the removal of wrecks obstructing or endangering navigation, for which provision is made in the river and harbor act of June 14, 1880, and enlarged by the river and harbor act of August 2, 1882.

Under section 4 of the river and harbor act of August 4, 1886, which requires the Secretary of War to report to Congress whether any

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bridges, causeways, or structures now erected, or in process of erection, do or will interfere with free and safe navigation, and if so, to report the best mode of altering or constructing the same; and which also requires a report to be made to Congress of all cases in which piers, breakwaters, locks, and dams, or other structures or works built or made by the United States in aid of commerce or navigation are used, occupied, or injured by a corporation or individual, and the extent and mode of such use, occupation, or injury, the Chief of Engineers was directed to report thereon as required by the act. A communication enumerating all instances of interference with free and safe navigation, not previously reported to Congress, was transmitted to the House of Representatives December 10, 1887, and on January 3, 1888, enumerating in like manner instances of the use or the occupancy of, or injury to, public works.

Improvement of South Pass, Mississippi River.—The record of this work, in last annual report of the Department, was brought down to September 29, 1887. Since that date the channel has been maintained, as required by law, for the full period of one year, to September 29, 1888, for which payments have been made amounting to $100,000. There has also been paid $50,000 for one year's interest on the $1,000,000 retained, making the total expenditures to September 29, 1888, inclusive, $5,600,000.

During the year mentioned there has been no failure in the maintenance of the channel.

Under the provisions of the act of March 3, 1875, and amendatory acts, one-half of the $1,000,000 remaining as security in the possession of the United States is to be released and paid to James B. Eads, his assigns or legal representatives, when the prescribed channel shall have been maintained for ten years, and as such period of maintenance will in all probability expire during the fiscal year 1890, an estimate for an appropriation of $500,000 has accordingly been submitted for the action of Congress. Should the appropriation not be made then, under the provisions of the act of March 3, 1875, the Secretary of the Treasury is directed to issue the bonds of the United States, bearing five per cent. interest, to said Eads or his legal representatives, in payment at par of the warrant issued by the Secretary of War, as directed in the same act.

Water supply of Washington, D. C.—The work of lining the tunnel with masonry had advanced September 1, 1888, in its total length to 13,080 feet, and there remained to be lined at that date 7,616 feet. The tunnel work was stopped on September 30, 1887, when the appropriation became exhausted. The deficiency act, approved March 30, 1888, appropriated the sum of $355,000 to complete the tunnel. On the reservoirs the work under contract was completed in October, 1887. The construction of the influent and effluent gate-houses, necessary before water can be let in, has been begun.

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The Potomac Flats.—In execution of the plan projected for this improvement, there has been dredged a channel from 350 to 550 feet wide and 20 feet deep, between Georgetown and Giesboro Point. The Washington channel has been dredged to a width of 350 feet and 20 feet deep, all the material being deposited on the flats, and up to the present time about 544 acres have been reclaimed from the overflow of ordinary high tide. Of the 12,000,000 cubic yards required to raise the flats to the proposed height of 3 feet above the highest freshets, about 6,511,000 have been deposited. On June 30, 1888, the expenditure for this improvement amounted to $1,247,495, less than half the estimated cost of the whole work.

A communication was transmitted to the House of Representatives February 18, 1888, calling attention to the probability of damage to this improvement, as well as to the water front of the city, from ice gorges and freshets and to the necessity of rebuilding, without delay, the Long Bridge, with wide spans and open piers, offering the least resistance to the flow of water in order to avert such damage. The right to repeal or annul the act of June 21, 1870, permitting the Baltimore and Potomac Railroad to use this bridge was reserved to Congress.

Attention is called to the report upon the construction of roads and bridges in the Yellowstone National Park, and to the necessity of further appropriation for this purpose. The number of visitors increases yearly, and in order that the Park may be fully maintained for the purpose for which Congress intended it, its various objects of interest should be made readily accessible. Owing to the lateness of the session at which appropriations are frequently made by Congress, the season when expenditures can be made here to the best advantage is lost for the fiscal year. It is therefore recommended, in order that work may be done at the most favorable time of the year, that appropriations for this object be made without limit, as is the case with the items of the river and harbor acts.

The small appropriation stated in the estimates for surveys required for military purposes, for the publication of maps, including lake charts and local surveys, and for additions to the engraved plates for the use of the War Department, is earnestly recommended.

BRIDGES OVER NAVIGABLE WATERS.

Attention is called to a recommendation in my report of 1885, and repeated in the reports of 1886 and 1887, that action is required on the part of Congress in the case of navigable streams within the limits of a State. Until Congress assumes control of such subject the power of a State over bridges across navigable streams within its limits is plenary.

The Attorney-General has decided that section 8 of the River and Harbor act of 1884 does not prevent the erection of bridges that obstruct such streams; and the ninth and tenth sections of the River and Harbor act of 1888 seem only to authorize the bringing of suits and a punish-

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ment by fine for obstruction. There are some cases where a railroad company could afford to pay the fine of $500 per month rather than make a proper bridge.

It is therefore suggested that some action should be taken by Congress to enforce the rights of the United States in navigable streams within the limits of a State, and thus give effect to the duty resting upon the Government to protect navigation thereon.

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ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY.

1888.

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REPORT

OF

THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 1, 1888.

SIR: I have the honor to present for your information the following report upon the duties and operations of the Engineer Department for the fiscal year ending June 30, 1888:

OFFICERS OF THE CORPS OF ENGINEERS.

The number of officers holding commissions in the Corps of Engineers, United States Army, at the end of the fiscal year was 107.

Since the last annual report the Corps has lost by retirement, death, and resignation five of its officers: Brig.-Gen. James C. Duane, who was retired June 30, 1888, under the provisions of section 1 of the act of Congress approved June 30, 1882; Col. Quincy A. Gillmore, who died at Brooklyn, N. Y., April 7, 1888; Capt. George M. Wheeler, who was retired June 15, 1888, in conformity with section 1251 Revised Statutes; Capt. Albert H. Payson, who resigned December 1, 1887; and Lieut. Oscar T. Crosby, who resigned October 22, 1887.

There have been added to the Corps three second lieutenants: two by promotion of graduates from the Military Academy, and one by transfer from the line. Three additional second lieutenants were appointed from the Military Academy to date from June 11, 1888, but they did not become available for duty until after the close of the fiscal year, and are therefore not included in the strength of the Corps.

On the 30th of June, 1888, the officers were distributed as follows:

Office Chief of Engineers	4
Fortifications and river and harbor works	20
Fortifications, river and harbor works, Board of Engineers, and Board of Visitors	2
Fortifications, river and harbor works, Board of Engineers, and supervising engineer	1
Fortifications, Board of Engineers, post of Willets Point, Engineer School of Application, and Battalion of Engineers	1
Fortifications, river and harbor works, and light-house duty	2
Fortifications, river and harbor works, and supervising engineer	1
River and harbor works	22
River and harbor works and light-house duty	4
River and harbor works and engineer officer, military division	1
River and harbor works, Mississippi River Commission, and Missouri River Commission	1

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River and harbor works and Missouri River Commission	1
Mississippi River Commission, Missouri River Commission, and light-house duty	1
Board of Engineers, Board of Visitors, and Light-House Board	1
Board of Engineers and Board of Visitors	1
Board of Engineers, Board of Visitors, and Mississippi River Commission	1
Public buildings and grounds	1
Washington Aqueduct	2
Battalion of Engineers and Engineer School of Application	12
Under orders	2
Leave of absence	6
Detached, on duty as engineer officers of military departments, with Light-House Establishment, at Military Academy, with Board of Commissioners of the District of Columbia, with the Mississippi and Missouri River Commissions, and at U. S. Infantry and Cavalry School	20
	107

The officers detached were on duty as follows:

Col. John G. Parke, Superintendent Military Academy	1
Maj. David P. Heap, engineer third light-house district	1
Maj. William Ludlow, engineer fourth light-house district	1
Maj. Charles W. Raymond, Engineer Commissioner of the District of Columbia	1
Maj. William S. Stanton, engineer first and second light-house districts	1
Maj. James F. Gregory, engineer secretary of the Light-House Board	1
Capt. John C. Mallery, engineer fifth and sixth light-house districts	1
Capt. Charles F. Powell, secretary and disbursing officer of the Mississippi River Commission	1
Capt. John G. D. Knight, instructor of engineering at the U. S. Infantry and Cavalry School	1
Capt. Philip M. Price and Lieut. John Biddle, on duty with Company E, Battalion of Engineers, and at the Military Academy	2
Capt. Thomas W. Symons and Lieut. James L. Lusk, assistants to the Engineer Commissioner of the District of Columbia	2
Lieut. Theodore A. Bingham, secretary and disbursing officer of the Missouri River Commission	1
Lieuts. Gustav J. Fiebeger, George W Goethals, and Eugene J. Spencer, on duty at the Military Academy	3
Lieut. John Millis, assistant to engineer, third light-house district	1
Lieut. William C. Langfitt, engineer officer Department of the Columbia	1
Lieut. Hiram M. Chittenden, engineer officer Department of the Platte	1
	20

SEA-COAST AND LAKE FRONTIER DEFENSES.

The act of February 10, 1875, gave the last appropriation for the construction of permanent defenses. Upon the expenditure of that appropriation all construction work ceased. The wisdom of providing for the public defense in time of peace, and while the Government is in a condition of financial prosperity, would appear to be too self-evident to need further demonstration. The matter has received the earnest attention of my predecessors for years past; their recommendations, as set forth in their printed annual reports, are exhaustive and are fully concurred in by me.

Attention is again invited to the detailed estimates for the construction of gun and mortar batteries, prepared by The Board of Engineers, and printed on page 11 of the last annual report. The total is presented in the estimates herewith, as are also estimates for the construction of torpedo casemates and galleries, and for the purchase of torpedo material for the defense of our chief sea-ports.

The acts of 1876, 1877, 1878, 1879, and 1880 appropriated each year for the protection, preservation, and repair of fortifications and other works of defense, $100,000; the acts of 1881, 1882, 1883, and 1884 gave annually $175,000, and the act of 1885, $100,000. This latter was the

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last appropriation, and was practically exhausted by the end of the fiscal year for which it was appropriated. The estimates of this office for the fiscal years ending June 30, 1887, 1888, and 1889, were $175,000 each, and the estimate for the fiscal year ending June 30, 1890, has been increased by $25,000 to cover additional damage and deterioration incident to over two years of absolute neglect. The failure to obtain any appropriations for 1887 necessitated the practical abandonment of all permanent and other defenses where there were no garrisons, or where ordnance sergeants could not be detailed to take charge. Portable property was secured as well as possible and the fort-keepers discharged.

Neglect of any structure, however massive or well built, results in more or less rapid deterioration, and we find to-day everything connected with our permanent defenses, which are dependent upon annual appropriations for their maintenance and repair, going to rack and ruin; slopes overgrown with grass and weeds and gullied by the rain; walks and roads ragged and untrimmed and full of holes and breaks; ditches and drains filled up or fallen in and pools of stagnant water on the parades and in the casemates; the sewers in bad order with the consequent evils; mortar and cement falling from the joints of masonry for want of repointing; timber gun and ammunition platforms rotten or decayed, and permanent concrete or masonry platforms settling or out of plumb, thus preventing the proper service of the guns; casemates and quarters leaky, unhealthy, and uninhabitable; magazines damp and useless; revetment walls on water fronts falling down, and waves making serious and rapid encroachments on valuable ground, thus impairing eligible sites for future works, and generally about the ungarrisoned forts an appearance of total abandonment and decay, and from the commanders of garrisoned forts continued and urgent appeals to keep the works in proper repair for the comfort and convenience of the garrison and the efficient use of the armaments.

Many of these works are still of value, either in themselves directly for minor defense, or, in connection with new works projected for the defense of our harbors. The estimate submitted is for the preservation and repair of such fortifications as are still of value.

ESTIMATES OF APPROPRIATIONS REQUIRED FOR 1889–'90.

For construction of gun and mortar batteries for defense of our chief sea-ports	$2,840,000
For protection, preservation, and repair of, and preparation of plans for, fortifications for which there may be no special appropriation available.	200,000
For purchase of submarine mines and necessary appliances to operate them for closing the channels leading to our principal sea-ports	300,000
For needful casemates, cable galleries, etc., to render it possible to operate submarine mines	1,560,000
For continuing torpedo experiments and for practical instruction of engineer troops in the details of service	30,000
For torpedo shed at San Francisco Harbor	22,000
Total	4,952,000

THE BOARD OF ENGINEERS.

The Board of Engineers stationed in New York City consisted of Col. Thomas Lincoln Casey, Col. Henry L. Abbott, Col. William P. Craighill, Col. Cyrus B. Comstock, Lieut. Col. David C. Houston, Lieut. Col. Walter McFarland, Maj. William R. King, and, when so ordered, the officer in charge of the work under consideration.

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During the fiscal year the Board has considered the questions referred to it by the Chief of Engineers, and of the reports submitted the following is a brief summary:

1887, July 5. Relative to the cutting down of cribs of the Buffalo Breakwater to receive masonry superstructure.

July 11. Improvement of Shrewsbury River, New Jersey.

July 19. Improvement of Aransas Pass, Texas.

July 19. On design for a disappearing gun-carriage by Maj. M. B. Adams, Corps of Engineers.

August 2. Estimates for appropriations for coast defenses, including submarine mines, for the fiscal year ending June 30, 1889.

October 24. Submarine defenses of New York Harbor.

November 11. Improvement of Brazos River, Pass Cavallo, and Brazos Santiago, Texas.

November 11. Submarine defenses of Boston Harbor.

December 20. Study for a typical mortar battery.

1888, January 3. In relation to Senate bill No. 62, Fiftieth Congress, first session, to provide for fortifications and other sea-coast defenses.

January 17. Submarine defenses of San Francisco Harbor.

January 20. In relation to Senate bill No. 1241, Fiftieth Congress, first session, to prevent obstructive or injurious deposits in New York Harbor.

February 10. Deepening of channels in New York Harbor.

February 11. In relation to Senate bill No. 1448 and House bill No. 4923, Fiftieth Congress, first session, for the establishment of a Bureau of Harbors and Water-ways.

March 16. On the paper of Prof. L. M. Haupt, of the University of Pennsylvania, relative to the physical features at harbor entrances.

March 16. Improvement of the Arkansas River.

March 16. Estimates for placing Fort Moultrie in a state of defense.

April 16. On leasing Government lands at Sandy Hook for hotel purposes.

April 25. Same subject.

May 4. On proposed right of way to the Birmingham, Mobile, and Navy Cove Harbor Railroad Company across the military reservation at Fort Morgan, Ala.

June 15. On design for a disappearing gun-carriage by Maj. M. B. Adams, Corps of Engineers.

June 15. Submarine defenses of Hampton Roads.

In the performance of the duties of the Board, the following personal examinations by committees were made:

1887, July 7. Visit to the forts in New York Harbor in connection with locations for torpedo casemates.

1888, May 3. Attendance at the annual examination of officers at the Engineer School of Application, Willets Point, N. Y.

June 22. Annual inspection of the Engineer School of Application, Willets Point, N. Y.

In addition to their duties with The Board of Engineers the individual members have been otherwise engaged as follows:

Col. Thos. Lincoln Casey, the President of the Board, has, as a member of the Light-House Board under the Treasury Department, attended the meetings of the Board from time to time in Washington. He continued in charge of the Washington National Monument until April 4, 1888, when he was relieved at his own request. He remained in charge of the construction of the State, War, and Navy Departments building until May 31, 1888, at which date the accounts and office were

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closed and his final report rendered to the Secretary of War. He has also served as a member of the Board of Visitors to the Engineer School of Application at Willets Point; as a member of Board of Engineer Officers on bridges across the Arthur Kill, Staten Island, New York; and upon special boards for the examination of officers of the Corps of Engineers for promotion.

Col. Henry L. Abbot has continued in charge of certain experiments with torpedoes and as a member of the Board of Officers and Civilians on Coast Defense. He has served as a member of the Board of Visitors to the Engineer School of Application and of special boards for the examination of officers of the Corps of Engineers for promotion, and on board to report on plan and location of bridge across the Mississippi River at Dubuque, Iowa. He examined and reported upon the site of the new bridge across the Arthur Kill, Staten Island, New York, and delivered a course of lectures on sea-coast defense at the Naval War College, Newport, R. I., during the term beginning in September, 1887. He was assigned to the charge of the office, the river and harbor works, and the fortifications of the late General Q. A. Gillmore at his decease, and has supervised the transfer of these works to the several officers now in charge. This duty is still unfinished.

Col. William P. Craighill has continued as a member of the Board since December 24, 1886, for the consideration of such matters of importance as the Chief of Engineers has designated. In addition to conducting the works of river and harbor improvement and fortifications with which he has been charged, he has been supervising engineer of the districts of Captains Hinman, Bixby, and Black, Lieutenants Abbot and Carter, United States Corps of Engineers, and Mr. S. T. Abert, United States agent, and has served on special boards as follows: For improvement of Cape Fear River, North Carolina; on improvement of the Potomac River, District of Columbia; on permanent improvement of Delaware River and Bay; on construction of the locks and canal at the Cascades, Columbia River, Oregon; on removal of islands and shoals in Delaware River between Philadelphia, Pa., and Camden, N. J., and as a member of joint advisory board to State harbor commissioners of Norfolk, Portsmouth, and Norfolk County, Va.

Col. C. B. Comstock returned to duty from sick leave of absence December 5, 1887. He has continued a member of the Mississippi River Commission, and has been its president since May 10, 1888; he has also served as a member of the Board of Visitors to the Engineer School of Application; on boards for improvement of Cape Fear River, and the Potomac River in the vicinity of Washington; and on board to consider and report upon removal of islands and shoals in Delaware River between Philadelphia, Pa., and Camden, N. J.; also a member of board for examination of officers of the Corps of Engineers for promotion.

Lieut. Col. D. C. Houston has been the disbursing officer of The Board of Engineers. He has conducted the various works of river and harbor improvement and of fortifications under his charge, and has served as a a member of the Board of Visitors to the Engineer School of Application.

Lieut. Col. Walter McFarland, in addition to conducting the works of river and harbor improvement and of fortifications with which he is charged, has served as a member of the Board of Visitors to the Engineer School of Application and of the Board on Improvement of Delaware River and Bay. He also inspected the works in charge of Majors Ernst and Damrell and Captains Hoxie, Taber, and Black.

Major William R. King has commanded the Post, the Engineer School of Application, the Engineer Depot, and the Battalion of Engineers at

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Willets Point, New York. He has had charge of the construction of Fort Schuyler, of fort and engineer depot at Willet's Point, of torpedoes for harbor defense, and of experiments with torpedoes; also charge of the construction of officers' quarters, mess, etc., at Willets Point, and of disbursements for the same. He has served on special board for examination of officers of the Corps of Engineers for promotion, and on board of engineer officers on bridges across the Arthur Kill, Staten Island, New York.

Sea-coast fortifications.—The Board of Engineers has nothing further to add to its reports of last year, contained in the Annual Report of the Chief of Engineers for 1887, respecting the necessity for modern defenses along the sea-board, and the urgency for the emplacement of high-power guns and rifled mortars in our important harbors, together with the preparation for the working and establishing of obstructions by mines in the fairways of approach to the several harbors in question.

POST OF WILLETS POINT, NEW YORK—ENGINEER SCHOOL OF APPLICATION—BATTALION OF ENGINEERS—ENGINEER DEPOT.

POST OF WILLETS POINT, NEW YORK.

At the close of the fiscal year ending June 30, 1888, the garrison consisted of 20 commissioned officers and 352 enlisted men.

During the year the Quartermaster's Department completed several much-needed improvements, such as the supply of water from the flushing works, bath-tubs, water-closets, etc., in barracks and quarters, an adequate sewerage system, new double set of officers' quarters, and new hospital; and began the laying of a system of brick side-walks.

Improvements recommended are: A new set of barracks; new quartermaster's and commissary store-house, properly located; to clean out and deepen the lagoon and ditch between the post and main land; the reconstruction of the soldiers' laboratory destroyed by fire in November, 1886; and a suitable building to contain the collection of engineer models.

The health of the garrison has been satisfactory (but four deaths, two accidental, in a population of over 600). With recent improvements and these herein proposed but little future trouble is anticipated.

SCHOOL OF APPLICATION.

During the past year two officers of engineers completed a three years' course, and three artillery officers a seven months course, and have been relieved.

The library of the school has received valuable accessions, and $500 is asked for the next year.

The officers have visited several large manufacturing establishments in the vicinity, witnessing mechanical operations, etc., of professional interest.

A greater number of artillery officers can be accommodated for instruction in torpedo service, and it is recommended that officers of cavalry and infantry, who so desire, be detailed for such instruction when enough artillery officers are not available.

BATTALION OF ENGINEERS.

The legal strength is 752 enlisted men in five companies; the authorized strength is 450. Companies A, B, and C are stationed at Willets

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Point, New York; Company E, at West Point, N. Y. Company D is not organized.

A roster of officers and changes is given in report.

Recruiting has been done by enlistments and re-enlistments at Willets Point, and by assignment from the general depot at David's Island, New York Harbor.

During the year the losses have been 134 and the gains 134.

The battalion has been drilled and instructed in the various subjects pertaining to their duties as engineer troops.

EXPERIMENTS.

In the absence of appropriations for "torpedoes for harbor defenses" for the past two years, no addition could be made to the supply of materials, and no systematic course of experiments could be made towards the future development of the system, to keep pace with improvements constantly being made in such appliances abroad.

A few simple experiments were, however, made with such facilities as were available, a brief account of which will be found in the report of the officer in charge of the Engineer School and Depot at Willets Point (Appendix No. 1).

ENGINEER DEPOT—PUBLIC BUILDINGS AND CONSTRUCTIONS.

The building for an officers' mess and library was completed and occupied during the year.

Instruments have been purchased, repaired, and, when required, issued to officers of the Corps in the field.

Observatory dome repainted. Water brought into officers' laboratory. The printing, book-binding, draughting, photographing, lithographing, engine-driving, general work of repair and preservation of property, buildings, and care of animals, have been done by engineer soldiers. The steamer *David Bushnell* was placed on the ways during the winter, but could not be repaired and launched in the spring, owing to a failure of the appropriation for the torpedo service.

A small testing-machine was improvised for measuring the strength of wire, rope, etc.

Materials required were purchased and issued for use here, and the necessary office work of the depot was performed.

STATEMENT OF FUNDS.

Congress appropriated for the fiscal year ending June 30, 1888	$6,500.00
Of this has been expended and pledged	6,494.32
No appropriation as yet available for the fiscal year ending June 30, 1889, except an extension for the month of July, 1888, of	540.99
There will be required for the fiscal year ending June 30, 1890—	
For incidental expenses of depot	$5,000.00
For purchase of materials for instruction	1,500.00
For purchase and repair of instruments	5,000.00
For purchase of professional works for the library	500.00
For a building to contain engineer models	8,000.00
In all	20,000.00

(See Appendix No. 1.)

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RIVER AND HARBOR IMPROVEMENTS.

The funds with which the works for the improvement of rivers and harbors were prosecuted during the past fiscal year were, owing to the failure of the river and harbor act passed during the second session of the Forty-ninth Congress to become a law, derived from balances remaining on hand from the act of August 5, 1886, together with such few remnants of former appropriations as were available. In many instances these being only sufficient to provide for the care of the public property pertaining to the works, operations were necessarily suspended, to the great detriment of the improvements concerned.

A brief statement, derived from the reports of the officers in charge of the several works, given below, sets forth the condition of each improvement, the extent of work performed during the last fiscal year, the amount expended, and, in compliance with the provisions of the river and harbor act approved March 2, 1867, estimates of the amount that can be profitably expended during the fiscal year ending June 30, 1890, with the probable cost of completion.

Although, as a general rule, regard is necessarily had, in the preparation of these estimates, to the more intimate acquaintance of the engineer officer in charge with the requirements of each locality, they have been carefully revised and amended when deemed advisable, in this office, the most economical administration of the works being considered as well as the average of the grants by Congress for each work during the past few years; and it has sometimes been necessary to make changes in the officer's estimates of the probable amount required for completion in consequence of appropriations made by the river and harbor act of August 11, 1888.

The examinations and surveys provided for by the river and harbor act of August 5, 1886, have been made and the results thereof reported to Congress from time to time, and such of them as were not contained in the report of this office for 1887 will be found in the appendix to this report.

Examinations were made during the fiscal year of such plans and locations as were submitted by parties interested, of bridges proposed to be built over navigable waters subject to the approval of the Secretary of War. A brief statement is given of the action had in such cases.

Examinations were also made whenever requested by committees of Congress, of proposed bills authorizing the construction of bridges, upon which the views of the War Department were desired. Of bills so examined during the present session of Congress to the close of the fiscal year, sixty originated in the Senate and eighty in the House of Representatives.

The reports heretofore made to Congress, up to the end of the fiscal year, in compliance with the requirements of section 2 of the river and harbor act of July 5, 1884, and section 4 of that of August 5, 1886, of instances where bridges, causeways, or other structures erected or in process of erection do or will interfere with free and safe navigation; and also of instances in which piers, breakwaters, or other works built by the United States in aid of commerce or navigation are used, occupied, or injured by a corporation or individual, will be found in Appendix WW 23 and XX, respectively, of this report.

A statement is also given of the work accomplished in the removal of wrecks obstructing or endangering navigation, general provision for which was made in the river and harbor act approved June 14, 1880, enlarged by provision of the river and harbor act of August 2, 1882.

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ATLANTIC COAST AND GULF OF MEXICO.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

Officer in charge, Lieut. Col. Jared A. Smith, Corps of Engineers.

1. *Lubec Channel, Maine.*—This channel lies between the eastern extremity of Maine and Campo-Bello Island, belonging to the Dominion of Canada. Originally the channel was but 5 feet in depth at mean low water, and but 2 feet at low water of spring tides.

The original project of improvement adopted in 1879, proposed widening and deepening the channel by dredging, where necessary, from the Narrows to the Western Bar Beacon, so as to give a width of 200 feet and a depth of 12 feet at mean low water, or 9 feet at low water of spring tides. This part was completed in 1883.

The present project contemplates increasing the width to 275 feet, and to 300 feet in the bends. Length of channel, 2½ miles.

The amount expended upon this improvement to June 30, 1887, was $139,932.04. The resulting improvement to navigation in this thoroughfare has been great, as it has made a channel of the specified depth, and varying from 200 to 278 feet wide, besides a stone jetty near the Narrows to direct the strong current.

During the last fiscal year there has been expended the sum of $9,057.93, in widening the channel by dredging, resulting in obtaining its full width for nearly half the length from the lower end.

The estimated cost of completing the improvement heretofore approved is $22,500.

It is proposed to expend any funds which may be available for the ensuing year in widening the channel to complete the present project as far as practicable.

July 1, 1887, amount available	$9,067.96
July 1, 1888, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1887	9,057.93
July 1, 1888, balance available	10.03
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	20,010.03
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 1.)

2. *Moose a bec Bar, Maine.*—The project for this improvement was adopted in 1881, the object being to give a direct channel over the bar having a width of 200 feet and a depth of 14 feet at mean low water. The old channel was indirect, crooked, and dangerous.

The entire amount expended to June 30, 1887, upon the improvement has been $30,393.11.

The dredged channel over the bar was completed in September, 1885, and there remains to complete the project only the removal of the small ledge known as "Steamboat Ledge." The amount available is sufficient to complete the work as originally planned.

The detailed survey of the ledge was completed in June, 1887, and a contract for removal of "Steamboat Ledge" to a depth of 15 feet at mean low water was concluded in August.

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Various delays have occurred to the contractor, so that the work is still unfinished. The work thus far completed under the contract has not been sufficient to improve the channel nor to involve any payments under the contract.

The contract has been extended to September 29, 1888, at which time it is expected that the removal of the ledge will be completed.

This channel is a thoroughfare for a very large number of coasting vessels and steamers. The improvements thus far made have been of very great benefit to navigation. The amount on hand will be expended in completing the original project.

The appropriation available will be expended in widening the channel and in the removal of some dangerous ledges one-half mile west of the bar.

July 1, 1887, amount available		$9,606.89
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$569.81	
July 1, 1888, outstanding liabilities	878.85	
July 1, 1888, amount covered by existing contracts	1,621.00	
		3,069.66
July 1, 1888, balance available		6,537.23
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		21,537.23

(See Appendix A 2.)

3. *Narraguagus River, Maine.*—The obstruction to navigation consisted in a bar extending from the anchorage known as "deep hole," near Fickett's Point, to deep water, the shoalest part having only 4 feet at extreme low water and only 5½ feet at mean low water.

The project for improvement adopted in 1886 consists in dredging a channel 11 feet deep at low water to the steam-boat landing at Long Point, and thence 9 feet deep to the deep hole, or anchorage, the width of the channel to be 200 feet throughout, except in the reach by the steam-boat wharf, where it is to be increased to 300 feet.

The estimated expense of the improvement was $50,000. The only expenses incurred previous to June 30, 1887, were for the necessary preparatory work, amounting to $257. In the last fiscal year there has been expended the sum of $9,743. Total expenditures, $10,000. A channel 11 feet deep has been dredged from deep water to a point above the lower steam-boat wharf, a distance of 5,000 feet, of which 3,550 feet is 50 feet wide and the remaining distance 75 feet wide. The lower steam-boat wharf can now be reached by steam-boats at all ordinary low-water stages, but this is of little value, as the steamers must wait for high water to enable them to turn around.

The mouth of the Narraguagus River forms a harbor which is somewhat used as an anchorage by coasting vessels. The steamers of the Portland, Bangor and Machias Steamboat Company touch at the Millbridge landing (Long Point) four times each week.

The $10,000 appropriated will be used in continuing the improvement. The balance required to complete the improvement is estimated at $30,000.

July 1, 1887, amount available	$9,743 00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,743 00
Amount appropriated by act of August 11, 1888	10,000 00

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Amount (estimated) required for completion of existing project	$30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1890.	10,000 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 3.)

4. *For commencing the construction of a breakwater from Mount Desert to Porcupine Island, Maine.*—This is a new work. The officer in charge, in his report upon the survey, made in compliance with the act of August 5, 1886, printed in Appendix A of the Report of the Chief of Engineers for 1887, page 483, stated that with the view to affording protection on the south and southeast sides of the harbor a breakwater is necessary, and that the only practicable location for it is between Round Porcupine Island and one of the adjacent points in Mount Desert Island. The estimated cost of the work is given at $500,000.

The river and harbor act of August 11, 1888, appropriates for commencing the work $50,000, and $100,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$50,000.00
Amount (estimated) required for completion of existing project	450,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

5. *Bagaduce River, Maine.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey was made of the Bagaduce River between the towns of Penobscot and Brooksville, Me.

A report of the results of the survey was transmitted to Congress February 8, 1888, and printed as House Ex. Doc. No. 157, Fiftieth Congress, first session.

The estimated cost of straightening and deepening the channel, proposed by the officer in charge, to give a width of 100 feet from Bridge's Point to the village of South Penobscot, with a depth of 5 feet at low water, is $45,000.

The river and harbor act of August 11, 1888, contains an appropriation of $3,000 for the proposed improvement, and $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$3,000.00
Amount (estimated) required for completion of existing project	42,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

6. *Bangor Harbor and Penobscot River, Maine.*—The present project for this improvement consists in widening the channel to 300 feet by dredging opposite Bangor to a depth of 11 feet at extreme low water, also to widen the channel and remove obstructions in Crosby's Narrows.

The estimated cost of the entire improvement is $75,000.

The former channel at Bangor was too narrow to accommodate the numerous vessels in connection with the lumber rafts, which often require much space.

There was expended upon the work to June 30, 1887, the sum of $20,403.97. The result was the required increase of width for a distance of over half a mile.

A contract for continuing the work has been in force during the last year, but the contractors have not made satisfactory progress. The

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improvement has been somewhat extended during the year. Work under the contract will be completed on or before October 15, 1888.

The amount expended during the fiscal year has been $4,391.10.

The balance of the available funds will be expended in continuing the contract, with the necessary contingent expenses.

The estimated amount required to complete the project is $40,000.

Under the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the Penobscot River from Bangor to Bucksport, Me. A report of the results of the survey was transmitted to Congress February 8, 1888, and printed as House Ex. Doc. No. 133, Fiftieth Congress, first session.

The officer in charge estimates the cost of the improvement he proposes at $365,000.

The amount available will be expended between Bangor and Crosby's Narrows, and Bucksport and Winterport.

July 1, 1887, amount available		$14,596.03
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,868.35	
July 1, 1888, outstanding liabilities	522.75	
July 1, 1888, amount covered by existing contracts	9,822.92	
		14,214.02
July 1, 1888, balance available		382.01
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		50,382.01

Amount (estimated) required for completion of existing project, subject to revision	355,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 4.)

7. *Belfast Harbor, Maine.*—The harbor was originally shallow along the wharf-fronts, east-side, so that vessels could only land on high stages of water. A project for the improvement of this harbor was adopted in 1876, the object being to enable vessels drawing 10 to 12 feet of water to reach the wharves at all stages of the tide.

Up to June 30, 1887, there had been expended the sum of $22,193.20.

The west side of the harbor has been improved so that there is 10 feet at mean low water in the upper part and 11 to 12 feet in the lower part.

The officer in charge recommends that the area of the harbor be increased by dredging the shoal on the northeast side to a depth not less than 8 feet at low water. He estimates the expense of dredging at $15,600, provided it can be expended in one sum.

The amount expended in the last fiscal year, making examination and report, has been $20.64.

July 1, 1887, amount available	$2,806.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20.64
July 1, 1888, balance available	2,786.16

(See Appendix A 5.)

8. *Camden Harbor, Maine.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Camden Harbor. A report of the results was

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transmitted to Congress February 2, 1888, and printed as House Ex. Doc. No. 141, Fiftieth Congress, first session.

A survey of this harbor was made in 1872, and subsequently two channels, each 80 feet wide and 6 feet deep, were dredged to the upper part of the basin. The present project contemplates dredging the approach to these channels to a depth of 10 and 12 feet; the deepening of the channels to 10 feet, and their extension to the upper end of the harbor with a depth of 5 feet at mean low water, at an estimated cost of $25,520.

The river and harbor act of August 11, 1888, appropriates $5,000 for this work, and a further sum of $10,000 could be profitably expended thereon during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	20,520.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

9. *Rockport Harbor, Maine.*—The river and harbor act of August 5, 1886, provided for a preliminary examination and survey of Rockport Harbor. A report of the results of the survey was transmitted to Congress February 2, 1888, and printed as House Ex. Doc. No. 141, Fiftieth Congress, first session, which contains an estimate of $14,000 for removing a shoal in the vicinity of the wharves to a depth of 12 feet mean low water. The present depth upon this shoal varies from 1½ feet to 11½ feet.

The river and harbor act of August 11, 1888, appropriates $10,000 for this harbor, and an additional sum of $4,000 could be profitably expended in completing the removal of this shoal during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

10. *Harbor at Rockland, Maine.*—The project for improving this harbor adopted in 1881, consists in the construction of two breakwaters to protect the shipping in the harbor and to make it a harbor of refuge. The harbor was open to all easterly winds and seas, and the breakwaters when completed will afford still water and good anchorage.

There had been expended on the improvement to June 30, 1887, the sum of $105,631.76.

As a result the breakwater from Jameson's Point had been completed its full length of 1,900 feet from high-water mark on shore, and to a height of 5 feet above mean low water. It has been found necessary to raise the top to mean high-water level, and this work has been commenced at the outer extremity.

During the year ending June 30, 1888, there has been expended the sum of $14,684.84. As a result the breakwater has been completed to high-water level, for a distance of 271 feet from the outer end, making it 20 feet wide on top.

The beacon has been removed from its old position and re-erected on the outer end of the breakwater.

The estimated cost of completing the first breakwater to the level of high water, and the second to mean sea-level, as originally planned, is $650,000. The amount that has been appropriated for this work is $122,500.

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The raising of the breakwater is expected to stop the seas which, at high water, now dash over its top.

The amount available and that asked for, will be applied towards completing the Jameson's Point breakwater to the level of high water.

July 1, 1887, amount available	$16,868.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14,684.84
July 1, 1888, balance available	2,183.40
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	32,183.40
Amount (estimated) required for completion of existing project	497,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 6.)

11. *Kennebec River at Bath and from Augusta to lower end of Perkins Island, Maine.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the Kennebec River at the localities named.

A report of the results of the survey was transmitted to Congress January 26, 1888, and printed in House Ex. Doc. No. 133, Fiftieth Congress, first session.

The former project for improving the river, completed in 1877, provided for a channel from Richmond to Gardiner, a distance of 11 miles, 100 feet wide and 10 feet deep at low water, or 15½ feet at high water, and from Gardiner to Augusta, 6 miles more, 100 feet wide, 6½ feet deep at low water and 11½ feet deep at high water.

The survey in question was limited to the portion of the river between Augusta and Gardiner and detached localities below.

The improvements proposed by the officer in charge are estimated to cost $410,500, the first in importance being the improvement of "Lovejoy's Narrows," at an estimated cost of $100,100.

The river and harbor act of August 11, 1888, appropriates $75,000 for this work, and $75,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$75,000.00
Amount (estimated) required for completion of existing project	335,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

12. *Harbor at Portland, Maine.*—The former projects for improving this harbor have been completed, and a depth of 17 feet mean low water has been obtained in all places where heretofore there was less than 16 feet, and the depth of 21 feet was extended beyond Galt Wharf to the southeast corner of Franklin Wharf. The present project consists in deepening the channel to give a depth of 29 feet at mean low water and a width of 500 feet to the wharves used by the largest transatlantic steamers at all stages of the tide.

The part of the harbor requiring this improvement had but 21 feet depth at low water, while the large steamers using it frequently draw as much as 27 feet.

Previous to June 30, 1887, there had been expended upon the project the sum of $2,040.59, mainly upon the preliminary work required. During the last year 198,872 cubic yards of material have been dredged and

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removed, resulting in giving a depth of 29 feet over an area of about 1,600 feet in length and 400 feet wide.

The amount expended in last fiscal year was $27,951.75.

The completion of the channel will be a great benefit to the facilities for receiving and shipping by transatlantic steamers and other large vessels.

The funds available and those asked for are to be expended in completing the project.

July 1, 1887, amount available	$27,959.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	27,951.75
July 1, 1888, balance available	7.66
Amount appropriated by act of August 11, 1888	40,000.00
Amount available for fiscal year ending June 30, 1889	40,007.66
Amount (estimated) required for completion of existing project	65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	65,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 7.)

13. *Channel in Back Cove, Portland, Maine.*—The project for this improvement, adopted in 1886, consists in widening and deepening the channel to give 12 feet depth at mean low water and a width of 300 feet for a distance of about 5,600 feet, following the harbor commissioners' line.

Originally the channel was only navigable at high stages of water; it was but 8 feet deep at low water, and that depth did not extend more than half its length.

Amount expended to June 30, 1887, was but $1,447.37, which was mainly for necessary surveys, maps, and other preliminary work.

During the last year, under the contract previously reported, there has been removed 49,602 cubic yards of material from the channel.

The expense of this work has been $9,281.02.

The resulting channel has the full depth and width of 72 feet for over 2,000 feet, and a width of 24 feet for 930 feet additional.

Fifty thousand dollars could be profitably expended in each year until the improvement is complete. The amount available and that asked is to be applied to extending and widening the channel.

The widening the channel as planned will greatly increase the facilities for receiving and shipping numerous freights, such as coal and building materials.

July 1, 1887, amount available		$24,802.63
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outsanding July 1, 1887	$6,880.35	
July 1, 1888, outstanding liabilities	2,400.67	
July 1, 1888, amount covered by existing contracts	14,950.00	
		24,231.02
July 1, 1888, balance available		571.61
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,571.61

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Amount (estimated) required for completion of existing project	$128,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 8.)

14. *Breakwater at mouth of Saco River, Maine.*—This breakwater was partially built in 1869 to 1873. In 1883 it was found necessary to complete the breakwater to the full height of 15 feet and top width of 12 feet, to secure the object of preventing the sand from drifting into the channel, and maintaining a bar at the mouth of the Saco River.

There had been expended upon this work to the 30th of June, 1887, the sum of $20,024.04.

As a result, the breakwater had been fully completed from its outer end, a distance of 710 feet, except the cap stones for 100 feet.

The completion of the breakwater thus far has had no perceptible effect upon the depth of water over the bar.

In the last fiscal year there has been expended the sum of $7,474.48.

The breakwater has been entirely completed to a point 1,310 feet from the outer end, repaired a further distance of 292 feet, and the beacon has been placed in a vertical position.

The original estimate, as amended, for completion of old breakwater was	$70,000
Amount appropriated	27,500
Estimated amount still required	42,500

This sum can be profitably expended in a single year.

The amount available and that asked for year ending June 30, 1890, are to be applied to completion of old breakwater.

July 1, 1887, amount available	$7,475.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,474.48
July 1, 1888, balance available	1.48
Amount appropriated by act of August 11, 1888	12,500.00
Amount available for fiscal year ending June 30, 1889	12,501.48

Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 9.)

15. *Saco River, Maine.*—The present project for improving the Saco River was adopted in 1886, its object being to give a channel having not less than 6 feet of water, at low water, to the cities of Saco and Biddeford.

The channel was obstructed by bars, and in one place by a ledge, and does not give more than 3½ feet of water at mean low water, though a large portion is much deeper.

The estimated expense, excluding the works necessary to remove the bar at the mouth, was $50,000.

Previous to June 30, 1887, the amount expended was $564.76. The expenditure was for the necessary surveys and preparatory work.

During the last year there has been expended the sum of $11,871.56. As a result the ledge at Little Islands has been removed, and the adjacent bars have been dredged to a depth of 6 feet at mean low water. A channel has also been dredged along the front of the coal wharves.

The amount available and that asked is to be applied in continuing the project.

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July 1, 1887, amount available	$11,935.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11,871.56
July 1, 1888, balance available	63.68
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,063.68
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 10.)

16. *Kennebunk River, Maine.*—All the projects for improving this river have been completed.

There have been no appropriations since 1881.

The small balance remaining June 30, 1887, has been partly expended in making needed repairs upon the old wooden pier.

The works completed consist of stone piers, supplemented by crib-work to keep the channel open at and near the mouth.

Total expended to June 30, 1887, $64,838.66.

No further improvements are at present contemplated.

July 1, 1887, amount available	$336.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	236.92
July 1, 1888, balance available	99.42

(See Appendix A 11.)

17. *Harbor at York, Maine.*—The project for this improvement adopted in 1886, has for its object the widening of the channel in three bends where it did not exceed 75 feet of a navigable depth, and where the tidal currents are very rapid. The channel at the points mentioned is to be widened by dredging and removing such rock as may be found.

The expenditures previous to June, 1887, were but $680.65, making no apparent change in the channel.

During the last year dredging has been done at two of the points mentioned.

The amount expended in fiscal year is $12,247.46.

The work accomplished thus far has not produced any material benefit. The entire completion, however, of the work proposed will greatly improve the navigation to and from the inner anchorage.

Part of the rock to be removed has been found a solid ledge instead of loose rocks, and the original estimate has, therefore, been increased by the amount necessary to remove this ledge, which is estimated to be $14,000.

The amount available and that asked for is to be applied to completing the project.

July 1, 1887, amount available	$14,319.35
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,247.46
July 1, 1888, balance available	2,071.89
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	12,071.89
Amount (estimated) required for completion of existing project	19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	19,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A 12.)

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18. *Harbor at Portsmouth, New Hampshire.*—The project for improving this harbor was adopted in 1879, the object being to check the strong tidal currents in the harbor and to give a navigable depth over the ledge known as Gangway Rock, opposite the navy-yard.

To June 30, 1887, there had been expended the sum of $94,730.36.

In the last fiscal year there has been expended the sum of $11,874 58.

The results are the entire removal of Gangway Rock to a depth of 20 feet at mean low water, the completion of the breakwater to stop the cross currents coming in from between Great and Goat islands, and a part of the ledge projecting from Badger's Island.

There remains to complete the original project only the removal of the remaining ledge on the point projecting from Badger's Island.

The officer in charge recommends that no further work be done upon that point, except so far as it may be considered desirable to remove the ledge to a depth not less than 18 feet, in order that passing vessels may not be injured by being drifted upon the jagged rock.

The estimated amount required to complete the original project is $25,000, but this is not recommended.

July 1, 1887 amount available	$12,269.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11,874.58
July 1, 1888, balance available	395.06
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,395.06
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1865 and 1867.	

(See Appendix A 13.)

19. *Bellamy River, New Hampshire.*—This is a new work, based upon the survey made in obedience to the requirements of the river and harbor act of August 5, 1886, in which the officer in charge reports that the river is a small tidal branch of the Piscataqua River, or an arm of Great Bay, which connects with the Piscataqua at Dora Point, 4 miles above the bridge at Portsmouth, N. H., which it is proposed to improve by dredging with the view to obtaining a channel sufficient to admit vessels of 500 or 600 tons to ascend to the head of navigation at that stage.

The estimated cost of the improvement, consisting of a channel 50 feet wide at bottom with 45-degree slopes, 5 feet depth at mean low water, is $28,000.

The river and harbor act of August 11, 1888, contains an appropriation of $10,000 for the proposed work. It is estimated that $18,000 can be profitably expended in fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	18,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	18,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

20. *Cocheco River, New Hampshire.*—The present project for improving the Cocheco River has for its object a channel 50 feet wide, with a depth of 5 feet at mean low water, or 11¾ feet at mean high water, to the city of Dover, N. H.

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The channel was obstructed by a ledge of rock, and by sand, gravel, and bowlders, which gave a channel depth of less than 3 feet at mean low water.

The original estimate for cost of the work was $47,000.

Expenditures to June 30, 1887, $28,497.36.

During the last year the removal of the solid ledge has been completed.

A great improvement to the navigation of the river has already resulted, but to obtain the full benefit the remaining obstructions should be removed.

The amount available will be applied to completing the improvement.

July 1, 1887, amount available	$9,502.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,184.75
July 1, 1888, balance available	317.89
Amount appropriated by act of August 11, 1888	9,000.00
Amount available for fiscal year ending June 30, 1889	9,317.89

(See Appendix A 14.)

21. *Harbor of Refuge at Little Harbor, New Hampshire.*—The present project for this improvement consists in dredging a channel 100 feet wide and 9 feet deep at mean low water for a distance of about 3,000 feet to the small anchorage, which is to be slightly enlarged.

The object of the improvement is to form a harbor of refuge for vessels when they can not get into Portsmouth Harbor.

The harbor has a sandy bottom, and is for the most part shallow. The channel originally had an average of less than 6 feet at low water.

The amount expended to June 30, 1887, was $349.71.

During the last year a part of the channel, 75 feet wide and 2,400 feet long, has been excavated to a depth of 9 feet by dredging.

The amount expended during the fiscal year has been $9,558.05.

The resulting channel causes no benefit thus far, because it does not extend to the deep water inside.

The funds available for ensuing year and for year ending June 30, 1890, will be expended in carrying out enlarged project in accordance with the act of August 11, 1888.

The increased depth and area to be dredged is estimated by the officer in charge to cost $95,000. If the project is to include the two protecting jetties proposed by him, $70,000 will have to be added to this amount.

July 1, 1887, amount available	$9,650.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,558.05
July 1, 1888, balance available	92.24
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	20,092.24
Amount (estimated) required for completion of existing project	98,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix A 15.)

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EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Lieutenant-Colonel Smith was charged with and completed the following surveys, the results of which were transmitted to Congress and printed as Executive Documents of the Fiftieth Congress, first session:

1. *Bayoduce [Bagaduce] River, Maine, between the towns of Penobscot and Brooksville.*—Printed in House Ex. Doc. No. 157. (See also Appendix A 16.)

2. *Camden Harbor, Maine.*—Printed in House Ex. Doc. No. 141. (See also Appendix A 17.)

3. *Rockport Harbor, Maine.*—Printed in House Ex. Doc. No. 141. (See also Appendix A 18.)

4. *Kennebec River, Maine, at Bath, and from Augusta, to lower end of Perkin's Island.*—Printed in House Ex. Doc. No. 133.—(See also Appendix A 19.)

5. *Penobscot River, Maine, from Bangor to Bucksport Narrows.*—Printed in House Ex. Doc. No. 133. (See also Appendix A 20.)

IMPROVEMENT OF RIVERS AND HARBORS IN MASSACHUSETTS.

Officer in charge, Lieut. Col. George L. Gillespie, Corps of Engineers.

1. *Newburyport Harbor, Massachusetts.*—The object of the improvement is to create a channel through the outer bar, 1,000 feet wide and with a least depth of 17 feet at mean low water, or 24½ feet at mean high water. The project adopted in 1880, and modified in 1883, is to build two converging rubble-stone jetties, so located as to give a proper direction to the current, and thereby produce and maintain the desired result.

The estimated cost of the project was $375,000, and the amount appropriated to date is $207,500.

To June 30, 1888, $207,498.27 had been expended.

During the fiscal year 3,443 tons of rubble-stone were deposited in the north jetty.

The north jetty is now 2,675 feet long, of which 1,930 feet are fully completed, and the residue, 745 feet, is a core of stone built up to low water.

The south jetty is 1,300 feet long, of which 1,077 feet are fully completed, and the residue, 223 feet, is a core of stone built up to low water.

The Plum Island Dike is 817 feet long, 5½ feet high above mean low water, except near the center where a weir is left temporarily, 150 feet long, and 2 feet deep at mean low water.

The sand-catch in rear of the south jetty is in two branches, one 480 feet long and one 572 feet.

All these works are in good order.

The expenditures during the year were $17,622.07.

The balance available July 1, 1888, is $1.73. To complete the improvements $167,500 will be required, of which $50,000 could be expended to advantage during the fiscal year ending June 30, 1890.

A survey of the bar was made in June, 1888. It showed a decided advance in the improvement; three deep navigable channels cross the bar, one 11.2 feet deep, and the other two, each 10.7 feet deep at mean low water.

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The advantages to be derived from the completion of the project are the deepening and widening of the channel across the bar, thereby affording a harbor of refuge on the inside of Salisbury Point, and also affording easy access at high water to the wharves at Newburyport for vessels drawing 17 feet approximately.

July 1, 1887, amount available	$17,623.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17,622.07
July 1, 1888, balance available	1.73
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,001.73
Amount (estimated) required for completion of existing project	142,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 1.)

2. *Merrimac River, Massachusetts.*—The object of the improvement is to straighten, deepen, and widen the natural channel of the river from its mouth to the Upper Falls, a distance of 21½ miles.

The channel originally was narrow, crooked, and much obstructed by ledges, bowlders, and shoals, and below Newburyport by ledges, cribs, piers, and wrecks. At mean low water vessels drawing not to exceed 7 feet could cross the bar and proceed about 6 miles above Newburyport. The mean rise or fall of the tide at the mouth of the river is 7½ feet; at Haverhill Bridge, 4 feet.

The project originally adopted in 1870 proposed to remove obstructions from the Upper and Lower Falls, to remove Gangway Rock, to remove the wreck of the schooner *Globe*, and to remove the "Boilers." The cost was estimated at $69,025.

This project was revised and extended in 1874 to include the removal of rocks at Deer Island and at Rock Bridges, and at Little Currier's Shoal, so that the channel should have the following depths at ordinary high-water stages of the river:

From the mouth to Deer Island Bridge (5 miles), 16½ feet; from Deer Island Bridge to Haverhill Bridge (12½ miles), 12 feet; thence to the foot of Mitchell's Falls (1½ miles), 10 feet; through Mitchell's Falls to the head of the Upper Falls (2½ miles), not less than 4½ feet, with the mill water at Lawrence running. This revised project was estimated to cost $147,000.

The total appropriations to date have been $170,500.

The total expenditures to June 30, 1888, were $170,498.43, and the river channel had been improved in accordance with the modified project, with the exception of the removal of the "Boilers," upon which no work has been done.

During the fiscal year the high-water grade line of the river during the spring freshet was established from Lawrence to the mouth.

To complete the improvement, so that the same depth of water which has been obtained through Mitchell's Falls can be carried to Lawrence, additional work will be required at the falls above Haverhill, which is estimated to cost $11,000, and additional improvements could be made in the lower part of the river, which are estimated to cost $11,500, or a total of $22,500.

The improved channel is in good order, and meets all existing demands of commerce. No appropriation is recommended for the year ending June 30, 1890.

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July 1, 1887, amount available		$290.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$282.47	
July 1, 1888, outstanding liabilities	6.00	
		288.47
July 1, 1888, balance available		1.57

(See Appendix B 2.)

3 *Powow River, Massachusetts.*—In compliance with river and harbor act of July 5, 1884, a preliminary examination and survey were made of Powow River. The result of the survey was submitted to Congress February 2, 1885, and printed as House Ex. Doc. No. 179, Forty-eighth Congress, second session, and also as Appendix B 15, Annual Report of Chief of Engineers, 1885. The project proposed contemplates deepening the channel to 12 feet for a distance of 9,600 feet, at an estimated cost of $77,000.

The river and harbor act of August 11, 1888, appropriates $3,000 for this work, and $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$3,000.00
Amount (estimated) required for completion of existing project	74,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

4. *Ipswich River, Massachusetts.*—Ipswich River empties into Plum Island Sound about 9 miles south of Newburyport, Mass. It is navigable from its mouth to the wharves at Ipswich, a distance of 3 miles. Before improvement at low water not to exceed 1½ feet draught could be carried in a narrow channel.

The mean rise or fall of the tide is 8.4 feet. The object of the improvement is to widen and deepen the natural channel of the river.

The original project was submitted in 1875. It proposed a channel 60 feet wide and 4 feet deep at mean low water, at an estimated cost of $25,000.

But one appropriation has been made for this improvement, that of August 5, 1886, for $2,500.

No operations were in progress during the year.

The improvement remains in good order, and the navigable channel is at least 40 feet wide and 4 feet deep at mean low water.

The total expenditures to date have been $2,500.

No balance is available July 1, 1888.

To complete the improvement so far as the nature of the present commerce justifies will require an appropriation of $2,500, all of which could be expended to advantage during the fiscal year ending June 30, 1890, in widening the cut at "The Shoals" to 60 feet and in extending it to the "Deep Hole" above "Heard's Point."

The prospective benefits to commerce are increased facilities and safety for navigation.

July 1, 1887, amount available	$246.79
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	246.79
Amount appropriated by act of August 11, 1888	2,500.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 3.)

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5. *Harbor of Refuge, Sandy Bay, Cape Ann, Massachusetts.*—This bay is situated at the northeastern extremity of Cape Ann, Massachusests. It is open to the full effect of easterly and northeasterly gales.

The proposed improvement contemplates the construction of a national harbor of refuge of the first class. The anchorage covered by the proposed breakwater will contain 1,377 acres.

No definite project for the masonry construction of the breakwater above the rubble mound has been adopted. To the level of 22 feet below mean low water it will consist of a mound of rubble-stone 40 feet wide on top.

The estimated cost of the improvement is $5,000,000.

The total amount appropriated to date has been $200,000.

The expenditures to June 30, 1888, were $194,125.24.

During the fiscal year ending June 30, 1888, 83,935 tons of rubble-stone were deposited in the breakwater.

The condition of the improvement on June 30, 1888, was as follows: 242,934 tons stone had been deposited, by which 2,200 running feet of the substructure of the breakwater were essentially completed.

The balance available July 1, 1888, $5,874.76, will be expended in making a survey of the substructure.

To complete the project will require an appropriation of $4,800,000, of which amount $100,000 could be expended to advantage during the fiscal year ending June 30, 1890.

The prospective benefits to commerce and navigation by the construction of this harbor of refuge are increased safety to life and property and a consequent reduction in freights and insurance.

July 1, 1887, amount available		$75,916.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$58,571.09	
July 1, 1888, outstanding liabilities	11,470.24	
		70,041.33
July 1, 1888, balance available		5,874.76
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		105,874.76

Amount (estimated) required for completion of existing project	4,700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 4.)

6. *Gloucester Harbor, Massachusetts.*—The general project submitted January 20, 1871, in compliance with the act of July 11, 1870, proposed to clear the harbor of sunken rocks, and to build a stone breakwater from Eastern Point to Round Rock Shoal. The operations in execution of this general project, under the acts of July 11, 1870, and June 10, 1872, have been confined solely to the removal of isolated sunken rocks, specially obstructive to the navigation of the inner harbor.

The act of July 10, 1872, appropriated $10,000, which sum was applied to the removal of Clam Rock, Pinnacle Rock, rock off J. Friend's Wharf, rock off Pew's Wharf, and a portion of Babson's Ledge.

The act of August 5, 1886, appropriated $5,000 for a survey of the harbor and for continuing work on Babson's Ledge. The survey was completed in December, 1886, and a report and general project, based on this survey, for the improvement of the harbor was published in the Report of the Chief of Engineers for 1887, page 500.

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The act of August 11, 1888, appropriates $10,000 for "dredging Harbor Cove and removing ledge and bowlders obstructing approach to the wharves between Harbor Cove and Pew's Wharf," which is a portion of the general project before referred to. The officer in charge estimated that this part of the project would cost $65,000.

July 1, 1887, amount available	$3,003.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,003.29
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 5.)

7. *Manchester Harbor, Massachusetts.*—In compliance with the provisions of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Manchester Harbor. The result of this survey was transmitted to Congress January 10, 1888, and printed in House Ex. Doc. No. 85, Fiftieth Congress, first session. The project proposed contemplates dredging a channel for a draught of 4 feet at mean low water from Proctor's Point to the town wharves, a distance of 3,900 feet, and the removal of a portion of a ledge of rock at Proctor's Point, at an estimated cost of $14,000.

The river and harbor act of August 11, 1888, appropriates $2,500 for this work, and $5,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$2,500.00
Amount (estimated) required for completion of existing project	11,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

8. *Lynn Harbor, Massachusetts.*—The object of this improvement is to obtain a more direct, wider, and deeper channel of approach to the city wharves. The original channels were narrow and crooked, and had but 6 feet depth at mean low water, and the greater part of the harbor was bare at low water.

The project was adopted in 1884. It proposed a channel 200 feet wide and 10 feet deep at mean low water through the outer and inner bars. The outer improved channel is 3,610 feet long; the inner one 6,450 feet. It is supposed that the inner channel will need occasional dredging. To aid in keeping the outer channel open a training-wall is proposed, if experience shall show it to be necessary. The cost of the project, as revised in 1885, was $157,000. The total appropriations to date are $66,000. The expenditures to June 30, 1888, were $65,962.60. During the fiscal year ending June 30, 1888, a survey of the improved channels was made, and it was found that they had suffered no serious deterioration and were essentially as at the date of the last annual report.

The outer channel is now completed. The inner channel is 150 feet wide, 10 feet deep at mean low water. No work has been done on the training-wall, as it has not yet been found necessary.

To complete the project would require an appropriation of $81,000.

To extend the inner channel to the basin between the city wharves would cost $25,000, a total of $106,000. The training-wall is estimated to cost $66,500

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Twenty-four thousand dollars could be expended to advantage during the fiscal year ending June 30, 1890, in widening the inner channel and its extension to the inner basin. The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1887, amount available	$566.86
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	529.46
July 1, 1888, balance available	37.40
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,037.40
Amount (estimated) required for completion of existing project	81,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	24,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 6.)

9. *Winthrop Harbor, Massachusetts.*—To comply with the provisions of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Winthrop Harbor.

A report of the results of the survey was transmitted to Congress January 10, 1888, and printed as House Ex. Doc. No. 85, Fiftieth Congress, first session.

It is proposed to dredge a channel 3,900 feet long, 50 feet wide, and 6 feet deep, to connect Rice's Wharf with the back channel, in order that vessels of light draught may reach Winthrop at all stages of tide, by way of the Bird Island Channel, at an estimated cost of $17,600.

The river and harbor act of August 11, 1888, contains an appropriation of $1,000 for this work.

It is estimated that $5,000 can be profitably expended during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$1,000.00
Amount (estimated) required for completion of existing project	16,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

10. *Boston Harbor, Massachusetts.*—The object of this improvement is, first, to *preserve* the harbor by protecting the islands and headlands; and, second, to *improve* it by widening, straightening, and deepening the channels.

The projects adopted for this purpose since 1866 have been mainly in accordance with the recommendations of the United States commissioners, whose labors terminated during that year. The works of preservation consist of sea-walls, aprons, jetties, etc., which protect the shores of the islands and headlands, prevent additional wash into the channels, control the tidal scour, and preserve the full height of anchorage shelter for vessels in the roadsteads. Such have been built or repaired at Point Allerton and the islands of Great Brewster, Lovell, Gallop, Long, Deer, Rainsford, George's, and Castle.

The works of improvement have been by dredging and blasting, by which means many dangerous rocks and shoals have been removed, and the main ship-channel enlarged from 100 feet wide and 18 feet deep at mean low water, so that it now is at least 600 feet wide and 23 feet deep at mean low water.

The following tributary channels have also been improved:

1. *Charles River.*—The natural channel of this river has been widened,

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straightened, and deepened, so that from its mouth up to Western Avenue Bridge, a distance of 4¾ miles, the channel has a width of 200 feet and a depth of 7 feet at mean low water; thence to Arsenal Street Bridge, 2½ miles, the channel has a least width of 80 feet and a least depth of 6 feet.

2. *Fort Point Channel.*—This important branch of the main ship-channel originally had a least depth of 12 feet at its entrance, and the channel was narrow and crooked. It has been widened to 175 feet and deepened to 23 feet at mean low water from its mouth to Congress Street Bridge, a distance of 1,900 feet.

3. *Hingham Harbor.*—(See separate report.)

4. *Nantasket Beach Channel.* The project adopted in 1880 was to widen and deepen the channel so that it would be at least 100 feet wide and 9½ feet deep at mean low water. The project was completed in 1881 and 1883.

5. *Channel between Nix's Mate and Long Island.*—This channel had originally 4½ feet depth at mean low water. A cut has been made through the bar 200 feet wide, 550 feet long, and 12 feet deep at mean low water.

This improved channel has proved to be of great convenience to the local commerce, and should be widened to 300 feet and deepened to 15 feet, mean low water, and its axis slightly changed.

6. *Broad Sound.*—An obstruction called "Barrel Rock" was removed in 1869.

The total appropriations to date for this harbor have been, since 1867, $1,663,750.

The expenditures to June 30, 1888, were $1,654,020.74 (inclusive of outstanding liabilities).

During the fiscal year ending June 30, 1888, 65,576 cubic yards of material were dredged from the "Lower Middle" Shoal and 3,430 cubic yards from the Narrows. The dredging at the "Lower Middle" uncovered three small ledges, and a contract for their removal was executed, under which work will be commenced early in July, 1888. When this contract is completed the channel here will be 1,000 feet wide. Six hundred and seventeen running feet of the coping course were reset at the Great Brewster sea-wall, and minor repairs made to the Deer Island sea-walls.

The several works of improvement are in good order and show no serious deterioration.

The existing works of preservation are generally in good order, but some of them require repairs and extensions.

The balance available July 1, 1888, will be expended in removing the small ledges uncovered by the dredging at the "Lower Middle."

The benefits to be derived from the proposed expenditure are additional safety and convenience to the commerce of this important harbor.

The amounts recommended by the officer in charge for expenditure for improvements in Boston Harbor, Massachusetts, during the fiscal year ending June 30, 1890, are as follows:

Extension of sea-wall:	
George's Island	$10,000
Gallop's Island	15,000
Extension, etc., of sea-wall at Long Island	3,000
Sea-walls at south and east bluffs of Governor's Island	80,000
Widening main ship-channel at the "Upper Middle"	250,000
Completing Fort Point Channel	60,000
Widening and deepening Nix's Mate Channel	25,000
Survey of main ship-channel east of Long Island Head	6,000
Total	449,000

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July 1, 1887, amount available		$34,718.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$23,396.04	
July 1, 1888, outstanding liabilities	1,587.12	
July 1, 1888, amount covered by existing contracts	6,600.00	
		31,583.16
July 1, 1888, balance available		3,129.26
Amount appropriated by act of Agust 11, 1888		125,000.00
Amount available for fiscal year ending June 30, 1889		138,129.26
Amount (estimated) required for completion of existing project		325,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix B 7.)

11. *Malden River, Massachusetts.*—The object of the improvement is to increase the width and depth of the river channel from its mouth to the second bridge in Malden.

Previously to the improvement there was a navigable depth of barely 7 feet at mean high water. The mean rise or fall of the tide is 9.8 feet.

The project originally proposed in 1880 was to excavate a channel 100 feet wide, 12 feet deep at mean high water, up to the second bridge in Malden, with two "cut-offs," one east of the island, near the mouth of the river, and one through the marsh, about one-half mile above.

This project was modified in 1882. It was then proposed to improve the natural channel of the river, so that it would be 100 feet wide, 12 feet deep at mean high water to the first bridge at Malden, and thence to the second bridge 75 feet wide, with the same depth.

The cost of the original project was estimated to be $40,000.

The total appropriations for this work are $10,000.

The expenditures to June 30, 1888, were $10,000. No work was done during the fiscal year ending June 30, 1888.

The channel of the river has a least width of 50 feet (70 feet at turns), with a depth of 12 feet at mean high water from its mouth to the first bridge in Malden.

There is no balance available July 1, 1888.

The improved channel is in good order.

No appropriation is recommended for the year ending June 30, 1890.

To complete the project it is estimated will cost $37,000.

(See Appendix B 8.)

12. *Hingham Harbor, Massachusetts.*—The object of the work is to widen and deepen the natural channel, which was 30 feet wide and 4 feet deep, so that it will be 100 feet wide and 10 feet deep at mean low water.

The project was originally proposed in 1874 and was modified in 1885. The original project was estimated to cost $11,000. The project of 1885 was to cost an additional sum of $18,750.

The total amount appropriated has been $16,000. The amount expended to June 30, 1888, was $16,000.

During the fiscal year ending June 30, 1888, no operations were in progress.

The channel is now 100 feet wide and 8 feet deep throughout, and at the ledge, where operations have been in progress under the modified project, the channel is 10 feet deep at mean low water in a cut through the ledge 50 feet wide.

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To complete the present project will require an appropriation of $8,000, all of which could be expended to advantage during the fiscal year ending June 30, 1890.

No balance is available July 1, 1888.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1887, amount available	$76.74
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	76.74
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 9.)

13. *Scituate Harbor, Massachusetts.*—This harbor is on the west shore of Massachusetts Bay, about 14 miles south of Boston Light.

The object of the improvement is to create a harbor of refuge for vessels bound to Boston from the eastward, which are too far south of their true course to clear the dangerous ledges near Minot's Ledge light.

Originally the harbor had a low-water area of about 57 acres, more than 6 acres of which had a depth of at least 3 feet at mean low water. It was entirely open to the action of easterly gales, and its entrance was obstructed by sunken bowlders.

The project adopted in 1880 is to build two breakwaters, one from "Cedar Point" on the north side of the entrance, and the other from the "First Cliff" on the south side; and to dredge the area inclosed, and in front of the entrance.

The estimated cost of the improvement is $290,000.

The total appropriations to date are $47,500.

The expenditures to June 30, 1888, were $47,500.

No operations were in progress during the fiscal year ending June 30, 1888.

The condition of the improvement is as follows: The north breakwater is essentially completed. Nothing has been done on the south breakwater. The entrance channel is 1,600 feet long, 100 feet wide, and 5 feet deep, at mean low water. The anchorage basin is 350 by 450 feet in area, 7 feet deep at mean low water.

No balance is available July 1, 1888.

To complete the improvement will require an appropriation of $242,500.

During the fiscal year ending June 30, 1890, $25,000 could be expended to advantage in commencing the south breakwater, and in enlarging the anchorage basin and the channel to the town wharves. The prospective benefits to commerce by the completion of this improvement are the creation of an additional harbor of refuge on this much-frequented, dangerous coast.

July 1, 1887, amount available	$474.72
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	474.72
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	267,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 10.)

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14. *Plymouth Harbor, Massachusetts.*—Plymouth Harbor is 30 miles south of Boston. The object of its improvement is to perpetuate the harbor by the preservation of Long Beach, which forms it, and to deepen and widen the channels of approach to an enlarged anchorage basin in in front of the town wharves.

The various devices employed for the preservation of Long Beach are described in the Annual Report of the Chief of Engineers for the year 1877.

The original project for improvement was adopted in 1875, and modified in 1877 and 1884. The modified project proposed an improved channel 2,286 feet long, 150 feet wide, and 9 feet deep at mean low water; leading to an anchorage basin 866 feet long, 150 feet wide, and 9 feet deep, at mean low water.

From 1866 to date $114,800 have been appropriated for this harbor. The expenditures to June 30, 1888, were:

For beach protection	$72,587.56
For dredging, etc	42,212.44
Total	114,800.00

During the fiscal year 8,312 cubic yards were dredged from the improved channel and basin. The channel is 115 feet wide and 9 feet deep at mean low water; the basin is 800 feet long, 9 feet deep for 90 feet of its width, nearest the town wharves, with an average of 5 feet deep for the remainder.

A survey of the improvement made in June, 1888, showed no deterioration since operations were suspended in July, 1887.

Long Beach is in good order throughout.

No balance is available July 1, 1888.

To complete the present project will cost $9,500.

The prospective benefits to commerce are increased facilities and safety to navigation.

July 1, 1887, amount available	$2,957.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,957.39
Amount appropriated by act of August 11, 1888	6,000.00
Amount (estimated) required for completion of existing project	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	9,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 11.)

15. *Wellfleet Harbor, Massachusetts.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Wellfleet Harbor, Cape Cod Bay. A report of the results of the survey was transmitted to Congress January 10, 1888, and printed in House Ex. Doc. No. 85, Fiftieth Congress, first session.

The proposed improvement contemplates the connection of the inner harbor, known as the Deep Hole Anchorage, with the wharves at Wellfleet by the excavation of a channel 4,200 feet long, 100 feet wide at bottom, and 6 feet deep at mean low water, at an estimated cost of $24,000.

Previous work at this harbor, consisting of the removal of several dangerous rocks, was completed in 1873 under appropriation of $5,000 made by river and harbor act of June 10, 1872.

The river and harbor act of August 11, 1888, appropriates $7,000 for

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this work. It is estimated that $10,000 can be profitably expended during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$7,000.00
Amount (estimated) required for completion of existing project	17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

16. *Provincetown Harbor, Massachusetts.*—This is one of the most valuable harbors of refuge on the Atlantic coast, and its existence depends entirely on the preservation of the sandy beaches inclosing it.

The project for its improvement was adopted in 1866 and modified in 1869, 1872, and 1873. It consists in the construction of detached bulkheads of wood and stone, jetties of wood and brush, dikes, sand-catches, and the extensive planting of beach grass, which has been remarkably successful.

From June, 1864, the allotments and appropriations for this harbor have been $139,478.44.

The amount expended to June, 1888, was $139,328.09.

During the fiscal year ending June 30, 1888, a wood and brush sand-catch, 232 feet long, was built on Long Point, near Wood End Light; the sand-catch near Abel Hill Dike was strengthened and enlarged, and about 5 acres of marsh grass were planted on House Point Island Flats.

At the date of this report all the works of preservation are in good order.

The balance available July 1, 1888, will be expended in examinations, etc.

During the fiscal year ending June 30, 1890, $2,500 could be expended to advantage in the repair of probable storm damages to the beaches.

The prospective benefit to commerce is the preservation of an important harbor of refuge.

July 1, 1887, amount available	$2,144.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,993.69
July 1, 1888, balance available	150.35
Amout appropriated by act of August 11, 1888	7,000.00
Amount available for fiscal year ending June 30, 1889	7,150.35
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix B 12.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Lieut. Col. Gillespie was charged with and completed the following surveys, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 85, Fiftieth Congress, first session.

1. *Manchester Harbor, Massachusetts.*—(See also Appendix B 13.)
2. *Winthrop Harbor, Massachusetts.*—(See also Appendix B 14.)
3. *Duxbury Harbor, Massachusetts.*—(See also Appendix B 15.)
4. *Wellfleet Harbor, Massachusetts.*—(See also Appendix B 16.)

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IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

Officer in charge, Maj. W. R. Livermore, Corps of Engineers, with Lieut. T. L. Casey, Corps of Engineers, under his immediate orders since October 26, 1887.

1. *Harbor of Refuge at Hyannis, Massachusetts.*—This harbor before improvement was an open roadstead exposed to southerly storms. In the years 1827–'38 a breakwater of riprap granite 1,170 feet long was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. Between the years 1852 and 1882 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water inside the breakwater is insufficient for many vessels that seek the harbor for refuge, and the present approved project contemplates dredging the area protected by the breakwater to a depth of 15½ feet at mean low water, at an estimated cost of $45,743.20. Congress made an appropriation of $10,000 therefor in the act of August 5, 1886.

The amount previously expended on this work up to June 30, 1887, was 124,163.18, with which the breakwater had been completed according to the original project and the subsequent plans for strengthening it. The amount expended during the last fiscal year, including outstanding liabilities, was $3,724.19 (making a total of $127,887.37 expended to June 30, 1888). The result has been the increase of the 15½-foot anchorage area protected by the breakwater by about 6.9 acres.

The amount available and the appropriation of $20,000 asked for is to be applied to extending the 15½-foot anchorage area.

July 1, 1887, amount available		$9,194.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,369.11	
July 1, 1888, outstanding liabilities	355.08	
July 1, 1888, amount covered by existing contracts	5,449.39	
		9,173.58
July 1, 1888, balance available		20.82
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,020.82
Amount (estimated) required for completion of existing project		25,662.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 1.)

2. *Harbor of Refuge at Nantucket, Massachusetts.*—This harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the north side of Nantucket Sound. It has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod.

Before the commencement of the present work there was a shoal about 1½ miles in width outside the entrance, through which the channel or line of best water was only about 6 feet deep, and very crooked, and subject to changes in location.

The present approved project is to construct jetties of riprap stone, projecting from either side of the present entrance to the harbor, for

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the purpose of concentrating the strength of the tidal currents, and excavating a channel of 15 feet depth, by scour, and at the places where the full depth required will not be reached by this means, to complete the work by dredging.

The amount expended on this project up to the close of the fiscal year ending June 30, 1887, was $111,531.77, and the result was the construction of the west jetty to a point 3,955 feet from the shore, and the east jetty to a distance of 330 feet from the initial point on the shore, and partially for an additional distance of 50 feet.

The amount expended during the last fiscal year, including outstanding liabilities, was $7,618.92 (making a total of $119,150.69 expended to June 30, 1888). The construction of the east jetty was continued and fully completed to a distance of about 385 feet from the initial point on the shore, and the foundation was laid and the jetty partially completed for an additional distance of 200 feet. The improvement in the depth of water noted as having followed the construction of the west jetty is still maintained.

The amount asked for, $50,000, is to be applied to the further extension of the east jetty.

July 1, 1887, amount available		$13,468.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,926.68	
July 1, 1888, outstanding liabilities	692.24	
July 1, 1888, amount covered by existing contracts	5,849.31	
		13,468.23
Amount appropriated by act of August 11, 1888		20,000.00
Amount (estimated) required for completion of existing project		230,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 2.)

3. *Harbor at Vineyard Haven, Massachusetts.*—This is a new work. A survey was made in compliance with the requirements of the river and harbor act of August 5, 1886.

The proposed project contemplates increasing its anchorage capacity, the dredging of the shoals which occupy a large portion of it, to a depth of 15 feet, and for completion of the protection of the harbor in northwesterly storms, the construction of a breakwater extending from a point nearly opposite to the West Chop to a point northeasterly from the East Chop, with jetties projecting from either chop, etc., the width of the western entrance to be 1,000 feet with a least depth of 25 feet at mean low water, at an estimated cost of $3,983,956.

The river and harbor act of August 11, 1888, contains an appropriation of $25,000 for this work, and $250,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888		$25,000.00
Amount (estimated) required for completion of existing project		3,958,956.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

4. *Wood's Holl Harbor, Massachusetts.*—Before improvement the site of the present works was a submerged point of land extending from the shore of the harbor. The adopted project for the improvement of the

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Great Harbor, Wood's Holl, was for the construction of retaining-walls on the shore, a hollow pier and wharves for the use of the United States Fish Commission, and to serve also as a coaling station for vessels of the Revenue Marine and other branches of the public service, and as a harbor of refuge, also for the removal of dangerous rocks from the strait of Wood's Holl.

A supplemental project for dredging in the rear of the coal-wharf extension to afford a berth for public vessels was approved November 27, 1885.

The amount expended on these works up to June 30, 1887, was $91,955.50. The retaining and pier walls, all the wharves, except a small amount of planking on coal wharf extension, the dredging of the interior of the hollow pier, the berths for vessels, and in rear of coal wharf extension had been completed, and the dangerous rocks in the straits removed.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $451.16, (making a total of $92,406.66 expended to June 30, 1888). The remainder of the planking was placed upon the coal-wharf and the project completed.

July 1, 1887, amount available	$451.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	451.16

(See Appendix C 3.)

5. *Wareham Harbor, Massachusetts.*—The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham. The commerce of Wareham is carried on in sailing-vessels, and the channel is to be made a beating channel for such vessels. Another object of the improvement is the raising of Long Beach.

Before improvement, the ruling depth in the harbor was about 7 feet at mean low water, in a narrow and very crooked channel. Long Beach, a narrow sand-spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

The original approved project of 1871, for the improvement, and its subsequent modifications, provides for a channel 250 feet wide and 10 feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth—10 feet—as below that point. The plan includes also the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there, in order to prevent the filling of the improved channel above by material abraded from the beach.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1887, including outstanding liabilities at that date, was $69,704.14, and the result was that the channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and the eastern half of the second and third reaches below the wharves, and one-fourth of the fourth reach, which extends to Barney's Point, were deepened to 10 feet at mean low water. The channel for about one-half its width from Barney's Point to Wareham has been deepened to 10 feet. Long Beach has been raised above high-water storm-tides, so that the wash of sand into the improved channel inside the beach has been stopped.

The ruling depth of the approaches to Wareham has been increased from 7 to 9 feet, and the channel greatly widened in all the reaches.

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Vessels of larger draught can be carried to Wareham than formerly. The increase in width of channel was a great help to all vessels in beating in and out of the harbor.

The amount expended during the last fiscal year, including outstanding liabilities June 30, 1888, was $2,320.49 (making a total of $72,024.63 expended to June 30, 1888), and the result was the further widening of the eastern half of the fourth reach below the wharves.

It is proposed to apply the balance on hand July 1, 1888, and the amount asked for ($4,000) towards the completion of the channel from the deep water above Long Beach to Wareham, and the further building up of Long Beach.

July 1, 1887, amount available		$10,295.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,816.50	
July 1, 1888, outstanding liabilities	503.99	
July 1, 1888, amount covered by existing contracts	7,975.47	
		10,295.96
Amount appropriated by act of August 11, 1888		4,000.00
Amount (estimated) required for completion of existing project		12,236.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,300.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 4.)

6. *New Bedford Harbor, Massachusetts.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of New Bedford Harbor.

A report of the results of the survey was transmitted to Congress, January 10, 1888, and printed in House Ex. Doc. No. 86, Fiftieth Congress, first session.

It is proposed to excavate a channel 200 feet wide and 18 feet deep, at an estimated cost of $35,000.

The sum of $20,000, appropriated by acts of March 3, 1875, and August 14, 1876, for this harbor, was expended in dredging. No work has been done since 1878.

The river and harbor act of August 11, 1888, contains an appropriation of $10,000 for the harbor, and the sum of $20,000 may be profitably expended in continuing the improvement during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

7. *Westport Harbor, Massachusetts.*—The object of the improvement is to prevent the washing away of Horse Neck Point and the filling of the channel by the eroded sand.

Before the commencement of the improvement the site of the present work was a point of sand forming the northern and eastern boundary of the entrance to the harbor and subject to erosion by the sea and tides. The approved project is to construct wooden jetties, filled with stone, at the end of Horse Neck Point, to stop the wearing of this point; the number and spacing of the jetties to depend on the price at which the work is let.

The available funds were sufficient to construct but one jetty. Work

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was commenced June 22, 1887, and was completed July 28, 1887. No further work is proposed.

The total expenditure has been $1,000.

July 1, 1887, amount available	$890.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	890.66

(See Appendix C 5.)

8. *Taunton River, Massachusetts.*—The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

The approved project of 1871 and its subsequent modifications provide for a channel 60 feet wide and 11 feet deep from weir bridge to the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Brigg's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton, were to be removed. The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1887, was $153,618.35.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard, on account of interfering with private property, and that the hardness and depth of material at the sides, the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge had been completed. The channel as proposed between Berkley Bridge and Dighton had been completed, with the exception of a small amount of dredging and the removal of the bowlders. The channel had been cleared of bowlders from Taunton down to Berkley Bridge. The work of removal of the ledge at Peter's Point had been completed. The material blasted in the channel had been dredged and deposited in the form of a half-tide dam running from Reuben's Island to the west shore of the river, with the view of accelerating the current in the dredged channel off and above Dighton, and preventing deposits in this part of the channel.

The amount expended during the fiscal year to June 30, 1888, including outstanding liabilities, was $3,317.59, making a total expenditure of $156,935.94 to June 30, 1888. The results were the completion of the channel as proposed between Berkley Bridge and Dighton, with the exception of a small amount of ledge rock uncovered in dredging below Peter's Point, leaving the channel above Berkley Bridge as at the beginning of the fiscal year, as stated above. Vessels of 11 feet draught can now reach Taunton, at the head of navigation.

There remains to complete the existing project, widening and deepening at a few points. A map of a survey of parts of Taunton River, with report thereon and project for further improvement, were submitted to Congress January 10, 1888, and printed as House Ex. Doc. No. 86, Fiftieth Congress, first session.

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The estimated cost of this additional improvement is $14,051.

July 1, 1887, amount available	$3,381.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,317.59
July 1, 1888, balance available	64.06

(See Appendix C 6.)

9. *Warren River, Rhode Island.*—Warren River is an arm of Narragansett Bay north of the harbor of Bristol. No appropriation for its improvement had been made until by the act approved August 5, 1886, Congress appropriated $5,000 for the purpose. The obstructions to navigation were a rocky reef below Little Island and a submerged bowlder near mid-channel opposite the lower wharves of the town of Warren. The approved project provided for the removal of these obstructions as far as could be done with an expenditure of $5,000.

The submerged bowlder was removed and an area of about 1.8 acres extending 550 feet along the narrowest part of the channel was cleared of the projecting points of ledge and bowlders between the months of August and November, 1887.

This completed the improvement as far as projected.

July 1, 1887, amount available	$4,969.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,699.39
July 1, 1888, balance available	270.11

(See Appendix C 7)

10. *Pawtucket River, Rhode Island.*—Before improvement the channel in the river had a ruling depth of about 5 feet at mean low water.

The original project for its improvement provided for a channel 75 feet wide and 7 feet deep at mean low water. This project was completed between the years 1868–1876.

The approved project of 1883 provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Co.'s Wharf at Pawtucket; thence the excavation by blasting of a channel through the ledge to Pawtucket Bridge of the same depth and 40 feet wide.

The amount expended to June 30, 1887, was $110,969.70. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water, and under the project as modified in 1883 a new channel 12 feet deep and 100 feet wide, with wide enlargements at the bends, had been carried from its mouth at the deep water just above Red Bridge, a distance of about 9,940 feet, to a point about 2,200 feet above a line drawn from Bucklin's Island to Swan Point Wharf.

The amount expended during the last fiscal year to June 30, 1888, including outstanding liabilities, was $20,160.29 (making a total expenditure of $131,129.99, to June 30, 1888), and the result is the extension of the channel about 2,800 feet up the river.

This completed portion of the channel is already a great benefit to the commerce of the river; a ruling depth of about 6 feet can be carried from the upper end of our present work to Pawtucket.

The work yet to be done is to excavate by dredging the channel 12 feet deep and 100 feet wide from Bass Rock to a point opposite Grant & Co.'s Wharf, and from thence to Pawtucket Bridge to deepen the channel through the ledge to the same depth with a width of 40 feet.

With the $50,000 asked for it is proposed to extend this channel further up the river.

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July 1, 1887, amount available	$21,036.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20,160.29
July 1, 1888, balance available	875.97
Amount appropriated by act of August 11, 1888	35,000.00
Amount available for fiscal year ending June 30, 1889	35,875.97
Amount (estimated) required for completion of existing project	367,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1856 and 1867.	

(See Appendix C 8.)

11. *Providence River and Narragansett Bay, Rhode Island.*—The object of this improvement is to furnish a wide and deep channel for foreign and coastwise commerce from the ocean to Providence.

Before the improvement of the river was commenced in 1853 many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet. There was expended between 1852 and the 30th June, 1882, $290,459 34 in deepening the channel, first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which the work is now in progress, provides for a channel 25 feet deep and 300 feet wide, suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage basin between Fox and Field's Points, 300 feet wide, at a depth of 25 feet; 600 feet wide, at a depth of 20 feet; 725 feet wide, at a depth of 18 feet; 940 feet wide, at a depth of 12 feet; 1,060 feet wide, at a depth of 6 feet.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1887, was $222,836.68. At that date about one-half of the excavation required for the anchorage basin above Field's Point had been done, Bulkhead Rock had been removed, and the 25-foot channel, 300 feet wide, from Providence to the deep water of Narragansett Bay, had been completed.

The amount expended during the last fiscal year to June 30, 1888, including outstanding liabilities, was $19,762.92 (making a total of $242,599.60 expended to June 30, 1888). The result was the completion of the excavation of the 20-foot anchorage area in the Fox Point Reach and about one-fourth of the same area in the Sassafras Point Reach.

There is required for the completion of the existing project the excavation of the remainder of the anchorage basin between Fox and Field's points.

With the amount available and the $100,000 asked for it is proposed to enlarge the anchorage area.

July 1, 1887, amount available	$20,763.95
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,762.92
July 1, 1888, balance available	1,001.03
Amount appropriated by act of August 11, 1888	40,000.00
Amount available for fiscal year ending June 30, 1889	41,001.03

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Amount (estimated) required for completion of existing project	$165,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 9.)

12. *Removal of Green Jacket Shoal, Providence River, Rhode Island.*—This shoal is in that part of Providence River which constitutes the harbor of Providence. It lies off the wharves on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes, covering an area of about 18 acres between the 15-foot curves.

The adopted project is the removal of the entire shoal to a depth of 25 feet at mean low water, limiting the work by lines drawn 200 feet from the harbor lines.

The amount expended during the last fiscal year, including outstanding liabilities, to June 30, 1888, was $24,388.13 (making a total expenditure of $25,155.60 to June 30, 1888), and the result was the excavation of an area of about 9¼ acres on the western side of the shoal to a depth of 25 feet at mean low water, making an important addition to the anchorage facilities of Providence Harbor. With the amount available and that asked for, it is proposed to continue the removal of the shoal as far as possible.

July 1, 1887, amount available	$25,482.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24,388.13
July 1, 1888, balance available	1,094.40
Amount appropriated by act of August 11, 1888	28,000.00
Amount available for fiscal year ending June 30, 1889	29,094.40

Amount (estimated) required for completion of existing project	58,096.00
Amount that can be profitably expended in fiscal year ending June 30, 1890.	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 10.)

13. *Newport Harbor, Rhode Island.*—Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of the vessels seeking it for refuge. The southern or main entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

The original project and its subsequent modifications under which work is now carried on are substantially as follows:

Deepening the southern entrance to 15 feet at mean low water, cutting away a portion of the spit which stretches out from the southerly end of Goat Island to the same depth, and constructing a jetty on the southwest shore of the island to arrest the drift of littoral sand and gravel into the entrance of the harbor; deepening to 13 feet at mean low water the area included between the 13-foot curve on the west, a line drawn from the southwest corner of Perry Mill Wharf to Lime Rock on the south, the harbor line on the east, and a line drawn parallel to and 50 feet from the city wharf on the north; deepening to 10 feet at mean low water the area northwest of a line drawn from Lime Rock through the spindle, which is in the southeast part of the harbor, and excavating a channel 10 feet deep at mean low water along and outside the harbor line south to a point opposite the gas company's wharf. Also the excavation of a channel 750 feet wide and 15 feet deep at mean low water around and to the eastward of the dolphin, which marks

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the Goat Island Spit, cutting away the spit to a depth of 15 feet at mean low water northward to a line drawn from the dolphin to clear the permanent dock at Fort Adams by 100 feet, and the construction of additional jetties on the western shore of Goat Island.

The amount expended up to the close of the fiscal year ending June 30, 1887, was $107,563.87, with the following results:

Of the area to be dredged to 13 feet within the harbor about nine-tenths had been completed, except at a few places in the northern part of the harbor, where the material was found too hard for the dredge in use at the time. The channel along and outside the harbor line south to a point opposite the gas company's wharf and the 15-foot channel, 750 feet wide, around and to the eastward of the dolphin on Goat IslandSpit, had been completed, with the exception of a strip along the western edge and to the north of the dolphin. The increase of width to be made between the 15-foot curves at the southern entrance by dredging in the spit south of Goat Island had been completed. Of the total area to be deepened within the harbor (about 90 acres) about two-thirds have been completed. The berth for vessels at the quartermaster's wharf at Fort Adams was deepened to 10 feet at mean low water, and the effectual stopping for the present of the supply of littoral sand and gravel from the outside of Goat Island into the southern entrance by the jetty on the southwest shore of the island. The southern entrance is completed for vessels of 15 feet draught.

The amount expended during the last fiscal year to June 30, 1888, including outstanding liabilities, was $560.36 (making a total expenditure of $108,124.23 to June 30, 1888), and the result was the completion of the contract then in force by the removal of a few bowlders found while dredging in the 13-foot anchorage area.

The work required to complete the existing project is the dredging of a narrow strip along the western edge of the 750-foot channel around and to the eastward of the dolphin on the Goat Island Spit, the remainder of the excavation within the harbor of the anchorage area of 13 feet depth, and the excavation, also within the harbor, of the anchorage area of 10 feet depth; also the building of additional jetties outside of Goat Island whenever they may be required to arrest the drift of littoral sand and gravel into the harbor entrance.

July 1, 1887, amount available	$638.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	560.36
July 1, 1888, balance available	77.80
Amount appropriated by act of August 11, 1888	12,000.00
Amount available for fiscal year ending June 30, 1889	12,077.80
Amount (estimated) required for completion of existing project	40,000,00
Amount that can be profitably expended in fiscal year ending June 30,1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C 11.)

14. *Harbor of Refuge at Block Island, Rhode Island.*—The object of the improvement is to furnish a harbor of refuge for vessels engaged in foreign and coastwise commerce.

Before the construction of the present harbor Block Island had no harbor which afforded protection for decked vessels. The original project and its subsequent modifications provide for a harbor of refuge on the eastern side of the island, consisting of an inner harbor or basin for small vessels and an exterior for large ones. The basin was to be

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about 250 feet by 300 feet in area and inclosed, with the exception of an opening 80 feet wide. The exterior harbor was to be formed by a riprap breakwater, which has been built. About 300 feet from the sea end of this breakwater, which is 1,900 feet long, a gap 200 feet long was left for the convenience of vessels. The present project contemplates the filling of this gap, which was found to let in too much sea in stormy weather, and the enlargement of the inner harbor by the construction of riprap walls inclosing an anchorage of about 18 acres.

The total expenditures up to June 30, 1887, were $325,024.17.

The inner harbor and the main breakwater, built in prolongation of the eastern side of the inner harbor and extending 1,900 feet from the shore, were constructed in the years 1870 to 1879, inclusive. The utility of the work at once became apparent. In stormy weather the inner harbor, especially, was filled with fishermen and coasters, and it soon became necessary to increase its depth from 7 feet, to which it had been dredged in the first instance, to 9 feet at mean low water. In 1883 a strong jetty was built out from the cliff to the eastward of the inner harbor, and a masonry wall was constructed on the inside of the crib-work forming the eastern side of the inner harbor. The filling in the gap in the main breakwater was carried to the height of about 1½ feet above mean high water, and at the close of the work under the last contract about one-half of the total amount of stone required for the completion of this work had been delivered and placed in the gap.

The sea, which formerly came into the outer harbor through the gap in the main breakwater in easterly storms, had been stopped by this partial filling.

During the last fiscal year work has been in progress on the filling of the gap in the breakwater and commencing the enlargement of the inner harbor. That portion of the current contract relating to the filling of the gap has been completed and the building of the riprap walls inclosing the enlarged inner harbor has been commenced.

It is proposed to apply the funds available July 1, 1888, to carrying on the work of the enlargement of the inner harbor. The appropriation asked for is for the completion of the filling of the gap in the breakwater, the restoring of the breakwater to its original dimensions, and the continuation of the enlargement of the inner harbor.

The result was the filling of the gap to within one-seventh of the total estimated amount, the construction of the timber jetty filled with stone forming the shore end of the western wall of the proposed enlarged inner harbor, and the commencement of the construction of its north wall.

July 1, 1887, amount available		$19,975.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,049.21	
July 1, 1888, outstanding liabilities	3,934.74	
July 1, 1888, amount covered by existing contracts	5,215.09	
		19,199.04
July 1, 1888, balance available:		
Breakwater	197.31	
Inner harbor	579.48	
		776.79
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,776.79
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix C 12.)

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15. *Pawcatuck River, Rhode Island and Connecticut.*—The navigable part of the Pawcatuck River extends from the town of Westerly to Little Narragansett Bay, and the object of the improvement is to deepen and widen the channel leading from this bay to Westerly.

Before improvement the channel was crooked and obstructed by numerous shoals, on some of which there was but 1½ feet of water at mean low water.

By appropriations made in the years 1871 to 1875 the river was improved by the excavation of a channel 5½ feet deep at mean low water and 75 feet wide below the wharves, and from 35 to 40 feet wide between the upper and lower wharves. The present approved project contemplates the further widening of the channel to 100 feet below the wharves and by an additional width of two cuts of an ordinary dredging machine, or about 49 feet between the lower and upper wharves; also the deepening of the entire channel to 8 feet at mean low water, at an estimated cost of $38,637. The amount expended on the original project was $50,000, and it was completed.

The amount expended on the present project to June 30, 1888, including outstanding liabilities, was $10,463.62, and the result was the completion of the channel to its full width and depth from the deep water opposite the village of Lottery to a point near the lower end of Major's Island, with the exception of a small amount of ledge rock which extends into the channel near Certain Draw Point and at the Pawcatuck Rock.

The work required to complete the existing project is the dredging of the channel to a depth of 8 feet at mean low water and width of 100 feet from the upper end of the present work to Westerly, and a width of 40 feet between the upper and lower wharves of that town; also the removal of a small amount of ledge rock when uncovered by dredging.

July 1, 1887, amount available		$8,464.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,184.13	
July 1, 1888, outstanding liabilities	1,744.37	
July 1, 1888, amount covered by existing contracts	1,137.38	
		8,065.88
July 1, 1888, balance available		399.00
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,399.00
Amount (estimated) required for completion of existing project		16,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		16,700.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C 14.)

16. *Harbor of Refuge at Stonington, Connecticut.*—Stonington Harbor originally was an open bay, unprotected from southerly storms, and obstructed by a shoal having a low-water depth of but 6 feet at the shoalest part. A short breakwater was constructed in the years 1828–'31, at a cost of $34,766.65, for the protection of the commerce of the town. The enlarged project of 1871 for the improvement of the harbor and its subsequent modification, under which work is now carried on, embraced dredging in the upper harbor and the construction of two breakwaters in the outer harbor. One of these, the western, was to be built out from Wamphassuck Point, the southwestern limit of the harbor, and to extend about 2,000 feet; and the other, the eastern, was to extend from the vicinity of Bartlett's Reef to the Middle Ground. The western break-

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water was completed in 1880, at a cost of $103,190. The amount expended in dredging in the upper harbor was about $45,000. The position of the western end of the eastern breakwater has not been determined.

The amount expended upon the eastern breakwater up to the close of the fiscal year ending June 30, 1887, was $105,115.19, and its length at that date was 2,150 feet.

The amount expended during the last fiscal year to June 30, 1888, including outstanding liabilities, was $4,433.71 (making a total expenditure of $109,548.90 to June 30, 1888), and the result was the extension of the eastern breakwater to a point about 2,210 feet from its eastern extremity.

The work required is to finish the construction of the eastern breakwater. In case it be found that sufficient protection to the harbor of refuge has been afforded when the range from Stonington Light to the middle of Wicopessit Island is reached the length of the breakwater yet to be built will be about 360 feet. Should it be decided to extend it to the Middle Ground it will require about 150 feet more.

The completion of this work will afford a thoroughly protected anchorage for vessels drawing 18 feet of water and a harbor of refuge for the commerce which daily passes between Long Island Sound and the eastward.

It is proposed to apply the amount available and that asked for to the extension of the eastern breakwater.

July 1, 1887, amount available	$4,884.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,433.71
July 1, 1888, balance available	450.80
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	8,450.80
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix C 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Major Livermore was charged with and completed the following surveys, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 86, Fiftieth Congress, first session:

1. *New Bedford Harbor, Massachusetts.*—(See also Appendix C 16.)
2. *Taunton River, Massachusetts.*—(See also Appendix C 17.)

IMPROVEMENT OF CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT, AND OF RIVERS AND HARBORS ON LONG ISLAND SOUND, CONNECTICUT AND NEW YORK.

Officer in charge, Lieut. Col. D. C. Houston, Corps of Engineers, with Lieut. J. C. Sanford, Corps of Engineers, under his immediate orders.

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1. *Thames River, Connecticut.*—This river is a tidal stream extending from the city of Norwich 15 miles south to Long Island Sound. For 11 miles above its mouth the depth ranges from 13 to 80 feet. Improvements have been confined to a stretch of 3½ miles below Norwich, in which the most troublesome bars lie. In 1829 the channel depth over these bars was about 6 feet at mean low water.

In 1836 a project was adopted for making the channel 100 feet wide and 14 feet deep at high water (11 feet at low water) by dredging and by building piers. In 1878 a channel 14 feet deep at low water was projected, and in 1882 a modification was adopted providing for a channel 200 feet wide and 14 feet deep, to be obtained by dredging and by building five dikes or training-walls along the outer curves of the channel. The estimated cost was $203,080, and a balance of $20,000 from previous appropriations was then available.

The total amount appropriated for this river is $304,300, of which $102,286.87 has been expended since the adoption of the present project.

Three of the proposed dikes have been completed, and 3,093 linear feet of the fourth one, or about two-thirds of its projected length, have been built. Dredging was done between the dikes in 1882, 1883, 1884, and 1887. The three completed dikes need slight repairs. The channel has about 10½ feet available depth at low water.

During the past fiscal year, including outstanding liabilities and excluding existing contracts, $13,136.87 have been expended in extending the fourth dike, in repairing the others, and in dredging.

Thirty-five thousand dollars could be advantageously expended in a single year in completing the remaining dikes and in dredging. The estimate for completing existing project has been enlarged by $24,000, the sum required for deepening the channel to 16 feet up to Allen's Point.

July 1, 1887, amount available		$21,137.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,136.87	
July 1, 1888, amount covered by existing contracts	6,650.00	
		19,786.87
July 1, 1888, balance available		1,350.89
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		51,350.89
Amount (estimated) required for completion of existing project		79,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix D 1.)

2. *New London Harbor, Connecticut.*—This harbor includes the lower 3 miles of Thames River, from the New London wharves to Long Island Sound.

The project for its improvement, adopted in 1880 and slightly modified in 1882, provides for removing to a depth of 16 feet at mean low water the southerly part of a shoal of sand and bowlders lying east of the New London Northern Railroad Wharf. The original depth on this part of the shoal was from 5 to 15 feet.

Nineteen thousand eight hundred dollars have been appropriated and expended on this work.

The required depth has been made over nearly the whole area con-

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templated in the project, which is regarded as completed, no further work under it being desired.

July 1, 1887, amount available	$204.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2.94
July 1, 1888, balance available	201.39

(See Appendix D 2.)

3. *Connecticut River, Massachusetts and Connecticut, above Hartford.*—From Holyoke, Mass., 34 miles above Hartford, down to Enfield Falls or Rapids, a distance of 18 miles, there is a fair channel 4 to 5 feet deep. Enfield Rapids extends about 5 miles over a rocky and uneven bed, with a total fall of 32 feet. From the foot of Enfield Rapids to Hartford, a distance of 11 miles, the river-bed is broad and sandy, with a channel from 2 to 5 feet deep at low water. Several years ago the Connecticut River Company constructed a small canal around Enfield Rapids, through which boats of 3 feet draught and 80 feet length can pass.

The several projects under which work has been done have been for dredging at Barber's Landing and for wing-dams. In 1878 plans and estimates were submitted for the construction of a canal 8 feet deep around Enfield Rapids; these estimates were revised in 1880. The estimated cost of this canal was $1,322,805; it was not considered advisable to begin construction with a less sum than $450,000, which has not yet been appropriated.

Up to the close of the present fiscal year $100,000 have been appropriated for this part of the river, of which $90,866.80 have been expended.

All the work done has been dredging, construction of seven wing-dams and repair of the same.

No work was done during the past fiscal year.

The funds on hand from previous appropriations are sufficient for such repairs and temporary improvement as may be needed during the ensuing year.

The benefit to be secured by a permanent improvement would be the reduction of cost of transporting bulky materials to and from a large manufacturing district, now wholly dependent on railroads.

July 1, 1887, amount available	$9,133.20
July 1, 1888, balance available	9,133.30

(See Appendix D 3.)

Below Hartford.—Between Hartford and Long Island Sound, a distance of 50 miles by course of channel, the depth on the two bars was formerly 5 feet at low water, the worst places being between Hartford and Middletown, a distance of 19 miles, and at Saybrook Bar, at the mouth of the river. Dredging was carried on and small wing-dams were constructed by private parties and by a State corporation up to 1868, with no permanent benefit.

In 1868 a project for improvement by the United States was submitted, under which a pile-dike was built at Hartford and annual dredging done on the bars below Hartford until 1883. In 1873 a project for the construction of three jetties on Saybrook Bar was adopted; two of these have been built; the third will probably not be required. In 1880 a project for permanent improvement on six of the worst bars between Hartford and Middletown was adopted; it contemplated building riprap wing-dams, rectifying the banks and protecting the caving banks

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by mattresses, at a total estimated cost of $330,487. It was afterward found necessary to extend the project to include annual dredging at these and other bars and the extension and repair of the Saybrook jetties. The total amount appropriated since the adoption of the above project is $161,250; two of the contemplated permanent works have been built, a training-wall at Hartford Bar and a wing-dam at Glastonbury Bar, their total cost being $40,715.34. In addition to the work included in the estimate of $330,487, the east and west jetties at Saybrook have been extended and repaired and a channel 120 feet wide and 12 feet deep has been dredged between them, and from $5,000 to $10,000 have been annually expended in dredging to maintain a depth of 9 feet on the bars between Hartford and Haddam Island.

Experience has shown that, on account of the height and frequency of freshets in this river, the permanent works projected in 1880 would be inadequate to maintain the desired depth or even to materially reduce the amount of dredging annually required; therefore, in December, 1887, a new project was adopted, confining future operations to the completion of the Saybrook jetties to a height of 5 feet above high water, with a top width of 6 feet and widening the channel between the jetties to 400 feet with a depth of 12 feet at mean low water, at an estimated cost of $80,000, with annual dredging to maintain a 9-foot channel between Hartford and Long Island Sound, at an average cost of $10,000 per year.

During the past fiscal year, including outstanding liabilities, $8,991.43 have been expended in repairing the Saybrook jetties and in dredging to maintain the 9-foot channel.

During the next fiscal year the Saybrook jetties could be completed as designed and the proposed dredging could be done at an estimated cost of $90,000, including $10,000 required for annual maintenance of channels.

July 1, 1887, amount available		$21,222.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,311.76	
July 1, 1888, outstanding liabilities	1,679.67	
July 1, 1888, amount covered by existing contracts	8,487.00	
		17,478.43
July 1, 1888, balance available		3,744.37
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		13,744.37

Amount (estimated) required for completion of existing project	80,000.00
Amount required for annual maintenance of channel	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix D 3.)

4. *Clinton Harbor, Connecticut.*—This harbor is 10 miles west of the mouth of the Connecticut River. Its channel runs for nearly a mile inside of a beach through which a breach was made about the year 1840, after which the channel shoaled in two places to about 4 feet depth, where the depth had been 8 feet.

The project for improvement, adopted in 1882, provided for closing the breach and, if that did not restore the channel depth, for dredging a channel 100 feet wide and 6 feet deep at mean low water through the shoals. The entire cost was estimated at $10,000.

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Three thousand dollars have been appropriated for this harbor, of which $2,747.27 have been expended.

A riprap dike was built across the breach in 1883; it requires some repair. The channel depth has not changed since 1882.

Nothing was done during the past fiscal year.

Seven thousand dollars, the estimated amount required to complete the project, could be profitably expended for that purpose in the following fiscal year.

July 1, 1887, amount available	$252.73
July 1, 1888, balance available	252.73
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 4.)

5. *New Haven Harbor, Connecticut.*—The original available low-water depth up to the wharves in this harbor was about 9 feet.

The first project for deepening the channel provided for making it 13 feet deep, which was done in 1871; it was widened at different times until 1878, when a project was adopted for dredging a channel 16 feet deep and not less 400 feet wide. In 1882 a project was adopted for building a dike to extend out from Sandy Point, with an arm 3,200 feet long and parallel to the channel, in order to contract the channel and make the depth to be obtained by dredging permanent. Thirth-eight thousand dollars have been expended on this dike, and $46,000 are estimated as required to complete it.

Up to the close of the fiscal year $261,000 have been appropriated for this harbor and nearly all expended.

A 16-foot channel from 400 to 600 feet wide has been obtained all the way up the harbor, except over the Fort Hale Bar, where the depth is 13 feet. The shore arm and 1,359 feet of the channel-arm of the Sandy Point Dike have been built.

During the past fiscal year $6,488.95 have been expended in extending the Sandy Point Dike 570 feet.

The sum of $93,000 is estimated as required to complete the dike and to do the necessary dredging to make 16 feet depth over the Fort Hale Bar.

July 1, 1887, amount available	$7,818.93
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,488.95
July 1, 1888, balance available	1,329.98
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,329.98
Amount (estimated) required for completion of existing project	78,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 5.)

6. *Breakwater at New Haven, Connecticut.*—In 1880 a project was adopted for making a large and convenient harbor of refuge at the entrance to New Haven Harbor by the construction of two riprap breakwaters, the first to be 3,300 feet long, extending northeasterly from the light-house on southwest ledge to Quixes ledge, the second to be 4,200

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feet long, extending northwesterly from Luddington Rock. The estimated cost was $1,311,134. No modification of the project has been made, except slight changes of cross-section in 1880.

The total amount appropriated for this work is $295,000, of which $288,497.64 have been expended.

The east breakwater has been built to a length of 2,818 feet, being nearly seven-eighths of its projected length. The west breakwater is not begun.

During the past fiscal year, including outstanding liabilities, and excluding existing contracts, $41,475.13 have been expended and the breakwater has been extended 406 linear feet; a contract for further extension is in progress.

The amount estimated as necessary to comple the east breakwater is $40,000; this could be done and work on the west breakwater prosecuted at the same time.

One hundred thousand dollars could be profitably expended on the two breakwaters during the ensuing year.

July 1, 1887, amount available		$47,977.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$39,786.28	
July 1, 1888, outstanding liabilities	1,688.85	
July 1, 1888, amount covered by existing contracts	6,411.15	
		47,886.28
July 1, 1888, balance available		91.21
Amount appropriated by act of August 11, 1888		75,000.00
Amount available for fiscal year ending June 30, 1889		75,091.21
Amount (estimated) required for completion of existing project		941,134.00
Amount that can be profitably expended in fiscal year ending June, 30, 1890		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix D 6.)

7. *Milford Harbor, Connecticut.*—This harbor consists of a broad open bay, from the head of which a small tidal stream extends three-quarters of a mile inland to the upper wharf. Originally the depth on the bar at the mouth of the river was less than 2 feet at mean low tide; the channel in the river ran nearly bare in places.

Under the first project of improvement, adopted in 1872, a channel 4 feet deep and 100 feet wide was excavated through the bar and thence 40 to 60 feet wide to the upper wharf; small jetties were built to protect the east bank from erosion and two jetties were built to preserve the channel on the bar, at a total cost of $34,600. In 1881 a project was adopted for making a channel over the bar, to be 8 feet deep at mean low water and 100 feet wide, at an estimated cost of $11,000.

The total sum appropriated for this harbor is $39,600; of this $4,758.98 have been expended on the last project and the 8-foot channel has been made 65 feet wide.

No work was done during the past fiscal year.

The remainder of the project could be satisfactorily completed in one year at the estimated cost of $6,000.

July 1, 1887, amount available	$241.02
July 1, 1888, balance available	241.02
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,241.02

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Amount (estimated) required for completion of existing project	$1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 7.)

8. *Housatonic River, Connecticut.*—The navigable part of this river extends from Derby, Conn., to Long Island Sound, a distance of 13 miles, and was originally obstructed by several bars, upon which the low-water depth was from 3 to 5 feet.

In 1871 a project was adopted for making and maintaining a channel 100 feet wide and 7 feet deep at mean low water throughout this distance. Besides the necessary dredging, it contemplated building a breakwater east of the channel over the bar at the river's mouth.

The amount appropriated for this river is $76,242, of which $74,494.59 have been expended, including outstanding liabilities.

A channel of the required depth has been dredged several times through the worst bars. The present available depth over them now is about 5 feet at mean low water. Drew's Rock has been removed to a depth of 7 feet at mean low water.

Revised estimates of cost of the breakwater at the mouth of the river and of the necessary dredging, have been submitted, amounting to $202,000; $70,000 of this could be advantageously expended during the ensuing fiscal year.

July 1, 1887, amount available		$6,975.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$825.96	
July 1, 1888, outstanding liabilities	4,444.00	
		5,269.96
July 1, 1888, balance available		1,705.41
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,705.41

Amount (estimated) required for completion of existing project	167,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	70,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 8.)

9. *Bridgeport Harbor, Connecticut.*—The available depth in this harbor was originally 5 feet at mean low water.

The first project for improvement provided for an 8-foot channel over the outer and inner bars; this was dredged on the outer bar in 1837, and on both bars in 1853. In 1871 a project was adopted for making a channel 12 feet deep and 100 feet wide, subsequently modified to 300 feet, and for building a jetty on the east shore to check the influx of sand. This was accomplished in 1882, and a new project was adopted for widening to 600 feet the channel from the Inner Beacon to the Naugatuck Railroad Wharf, to provide for vessels driven in by bad weather without blocking the main channel. The estimated cost of the latter project was $60,000. It is very nearly completed; a small area remains near the Inner Beacon, which it is considered desirable to dredge.

The total amount appropriated for this harbor is $232,485.38, of which $35,000 have been appropriated for and nearly all expended upon the project of 1882.

During the past fiscal year dredging has been done upon part of the area near the Inner Beacon.

An estimate for widening the channel above the railroad wharf, in

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order to relieve the crowding of the channel at that point, has been submitted. The cost is estimated at $17,000.

July 1, 1887, amount available		$2,478.07
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$321.01	
July 1, 1888, outstanding liabilities	1,960.00	
		2,281.01
July 1, 1888, balance available		197.06
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,197.06
Amount (estimated) required for completion of existing project		7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix D 9.)

10. *Black Rock Harbor, Connecticut.*—This harbor consists of a bay partly sheltered by Fairweather Island and of two small streams extending inland from the head of the bay. The depth in Cedar Creek, the more important of these streams, was from 2 to 4 feet at mean low water and the channel was narrow and very crooked.

The project for improvement submitted in 1883 includes dredging a channel 3,300 feet long, 80 feet wide, and 6 feet deep, to extend up Cedar Creek, and a breakwater from Fairweather Island to the mainland. The estimated cost was $80,000.

Twenty-five thousand dollars have been appropriated for and nearly all expended under this project.

The breakwater has been built to the full length, but not to the width and height projected, and the channel has been dredged 80 feet wide, but has filled in at the sides so that the available width is about 60 feet.

During the past fiscal year $2,391.29 have been expended in dredging to widen the channel as above.

July 1, 1887, amount available	$2,531.59
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,391.29
July 1, 1888, balance available	140.30
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,140.30
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 10.)

11. *Norwalk Harbor, Connecticut.*—This harbor consists of the tidal part of Norwalk River, extending from Norwalk, Conn., to Long Island Sound, a distance of 3 miles. South Norwalk is 1½ miles below Norwalk. Originally the depth up to South Norwalk was about 5 feet at mean low water; between there and Norwalk the bed ran nearly bare.

The first project for improvement contemplated a channel 100 feet wide and 6 feet deep from Long Island Sound to Norwalk. In 1881 the project was modified to provide for 8 feet depth below South Norwalk. The last estimate upon this work places the cost from commencement at $84,000.

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Up to the close of the fiscal year $77,246.66 had been appropriated for this project and nearly all expended. Some parts of the river have required dredging several times.

A channel has been dredged 100 feet wide and 8 feet deep up to South Norwalk, and thence to Norwalk from 60 to 100 feet wide and 6 feet deep. This channel is in navigable condition, though it has shoaled somewhat in places.

No work was done during the past fiscal year.

For the next fiscal year $7,000 could be profitably applied towards completing the present project and maintaining the channel depths.

The river and harbor act of August 11, 1888, appropriates $28,000 for the improvement of this harbor, and provides that $25,000 of this amount shall be expended in dredging and deepening the channel in the lower harbor up to Wilson's Point. The officer in charge estimates that this dredging will cost $52,900.

July 1, 1887, amount available	$560.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	56.94
July 1, 1888, balance available	503.10
Amount appropriated by act of August 11, 1888	28,000.00
Amount available for fiscal year ending June 30, 1889	28,503.10
Amount (estimated) required for completion of existing project	31,900.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 12.)

12. *Harbor at Five Mile River, Connecticut.*—This is a new work. A preliminary examination and survey of this harbor were made in compliance with the requirements of the river and harbor act approved August 5, 1886.

The proposed project contemplates deepening the harbor and approaches so as to give 8 feet at mean low water. It is proposed to dredge a channel 8 feet deep, 100 feet wide, and 6,000 feet long at an estimated cost of $25,000 and an annual expenditure of about $1,000 for maintenance.

The river and harbor act of August 11, 1888, appropriates for this work $5,000, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

13. *Stamford Harbor, Connecticut.*—This harbor consists of a shallow bay on the north shore of Long Island Sound and of the tidal part, about three-fourths of a mile long, of Mill River. The original depth in this part of the river at mean low water was from 1 to 3 feet, gradually increasing in the bay to depth of 12 feet.

The project for improvement, proposed in 1883 and adopted in 1886, provides for dredging a channel 80 feet wide and 5 feet deep at mean low water from the bay to the head of the harbor, at an estimated cost of $20,000.

Ten thousand dollars have been appropriated and expended under this project, making a channel 75 feet wide for more than half its projected length and 25 to 50 feet wide for the rest of the length.

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During the past fiscal year $5,469.66 were expended and the contract under which the above dredging was done was completed.

July 1, 1887, amount available	$5,693.74
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,469.66
July 1, 1888, balance available	224.08
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,224.08
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 13.)

14. *Port Chester Harbor, New York.*—This harbor consists of a bay opening into Long Island Sound at the mouth of the Byram River, and of the lower part of the river itself, which is navigable for about a mile above its mouth.

The original available depth in the river was not above a foot at low water, and Salt Rock in the river and Sunken Rock in the bay were considered dangerous obstructions.

The scheme for improvement adopted in 1871 provided for the removal of these rocks to 9 and 11 feet depth, respectively, and for the construction of a breakwater on the bar at the mouth of the harbor at an estimated cost of $96,632.

In 1884 the project was amended to provide for dredging a channel 2½ feet deep and from 60 to 100 feet wide from the bay to the vicinity of the wharves.

The total amount appropriated for this harbor is $27,000, which has been nearly all expended. Salt Rock has been removed to the required depth of 9 feet at mean low water, and a channel 2½ feet deep and from 40 to 100 feet wide has been completed to a point 150 feet below the bridge at Port Chester, and thence carried, with a width of 25 feet, to the bridge.

July 1, 1887, amount available	$24.77
July 1, 1888, balance available	24.77
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,024.77
Amount (estimated) required for completion of existing project	64,632.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 14.)

15. *Mamaroneck Harbor, New York.*—This harbor consists of a narrow inlet opening into a broad bay. Several dangerous rocks lie in or near the channel. The low-water depth to the old steam-boat wharf, about half-way up the inlet, was 5 feet; from there to the upper wharves it was about 1 foot.

A project for improvement was adopted in 1882, providing for the removal of one rock to 4 feet depth, of five rocks to 7 feet depth, and for making a channel 100 feet wide and 7 feet deep up to the old steam-boat wharf, thence to the village wharves 80 feet wide and 4 feet deep; the estimated cost was $43,000.

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Fifteen thousand dollars have been appropriated for this harbor and nearly all expended.

Three of the rocks have been removed to the required depth; no dredging has been done. The river and harbor act of August 11, 1888, made no appropriation for this harbor.

July 1, 1887, amount available	$220.55
July 1, 1888, balance available	220.55
Amount (estimated) required for completion of existing project	28,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 15.)

16. *Echo Harbor, New Rochelle, New York.*—The channel of this harbor was obstructed by two reefs, Start Rock and Sheepshead Rock, the former bare at low water, the latter covered to a foot depth or more.

The project for improvement adopted in 1876 provided for the removal of these reefs to 7 feet and 9 feet depths, respectively. The estimated cost was $38,955.38.

Twenty-two thousand dollars have been appropriated for this harbor, of which $18,956.03 have been expended. Start Rock has been wholly removed to 7 feet depth and part of Sheepshead Rock to 9 feet depth.

The available funds were not sufficient for continuing operations on Sheepshead Rock, and nothing has been done during the last fiscal year.

According to the estimate the amount required for completion of the project is $17,000.

July 1, 1887, amount available	$6,043.97
July 1, 1888, balance available	3,043.97
Amount (estimated) required for completion of existing project	17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 16.)

17. *New Rochelle Harbor, New York.*—This harbor consists mainly of a narrow and crooked channel lying between rocky islands.

The project for improvement, adopted in 1881, provided for the removal of two rocks and for dredging and removing a reef, to secure a channel 8 feet deep and 100 feet wide between Hunter's Island and Glen Island.

The estimated cost was $40,825.

Thirty-five thousand dollars have been appropriated for this work; of this sum $25,865.03, including outstanding liabilities have been expended.

The channel has been dredged to a depth of 6 feet and the rock removed to a depth of 7½ feet; one of the rocks, Corning Rock, has been removed to the required depth of 12 feet; upon the other, Rock C, no work has been done.

Two rocks, not shown on the original survey, have been removed during the past fiscal year to a depth of 8 feet and 7½ feet respectively.

July 1, 1887, amount available		$16,843.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,518.69	
July 1, 1888, outstanding liabilities	190.00	
		7,708.69
July 1, 1888, balance available		9,134.97

(See Appendix D 17).

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18. *East Chester Creek, New York.*—This is a small tidal stream, emptying into Pelham Bay; it was navigable at high tide for vessels drawing 7 feet up to Lockwood's, a distance of 2¼ miles. The rise of tide is 7.1 feet.

The project for improvement, adopted in 1872 and subsequently modified, provided for a channel 9 feet deep at mean high water, extending to a point 3,000 feet above Lockwood's and terminating at the upper end in a tidal basin, and for 5,800 feet of diking to maintain the channel. A revised estimated cost of the project, as modified, is placed by the officer in charge at $221,100.

Sixty-four thousand dollars have been appropriated, and of this amount $56,379.80, including outstanding liabilities and excluding existing contracts, have been expended.

The channel has been made 9 feet deep and 125 feet wide to the head of Goose Island, one-half mile from the mouth of the creek; thence to Town Dock from 40 to 90 feet wide, and from Town Dock to Lockwood's 100 feet wide, and 1,235 linear feet of diking have been built.

A contract for dredging was entered into July 11, 1887, and annulled August 18, 1887, on account of the contractor's failure to begin work. A second contract was entered into May 11, 1888; work under this contract is now in progress.

July 1, 1887, amount available		$9,673.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,256.18	
July 1, 1888, outstanding liabilities	797.40	
July 1, 1888, amount covered by existing contracts	6,852.60	
		8,906.18
July 1, 1888, balance available		767.60
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,767.60
Amount (estimated) required for completion of existing project		152,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix D 18.)

19. *Greenport Harbor, New York.*—This harbor, at the eastern end of Long Island, is exposed to easterly storms. Its anchorage-ground, which was sheltered by Joshua's Point, has materially shoaled by erosion of the point and by the influx of drifting sand.

The project of improvement, adopted in 1882, provided for construction of a riprap breakwater, extending from Joshua's Point 1,700 feet in a southeasterly course, to arrest drifting sand, to check the erosion of the point, and to increase the sheltered area. Its cost was estimated at $46,000.

Twenty-five thousand dollars have been appropriated for this habor, of which $24,959.90 have been expended.

The breakwater has been built out to a depth of 15.4 feet a distance of 1,437 feet. One thousand eight hundred and six and one-quarter tons of stone have been placed in the breakwater during the past fiscal year.

July 1, 1887, amount available		$2,957.93
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		2,917.83
July 1, 1888, balance available		40.10
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,040.10

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Amount (estimated) required for completion of existing project	$16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 19.)

20. *Glen Cove Harbor, New York.*—This is a new work. The harbor is a part of Hempstead Bay. An examination and survey of it was made in compliance with the requirements of the river and harbor act of August 5, 1886, and the report thereon printed as Appendix D 26 of the Report of the Chief of Engineers for 1887.

The proposed improvement consists in the construction of a breakwater from Musquito Point in a westerly direction to a length of about 2,500 feet, to afford shelter to vessels lying at anchor, waiting to pass into the harbor, and to protect its entrance. The estimated cost of the proposed breakwater is $201,960.

The river and harbor act of August 11, 1888, makes an appropriation of $20,000 for improving the harbor, and a further sum of $30,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$20,000.00

Amount (estimated) required for completion of existing project	181,960.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

21. *Flushing Bay, New York.*—Before improvement, the available depth in this broad, shallow bay and in the channel leading up to Flushing was less than 4 feet at mean low water.

The project for improvement, adopted in 1879, contemplated building 16,700 feet of diking, to form a tidal basin, which by filling and discharging through the main channel would maintain a channel depth of 6 feet or more at mean low water after once dredging; the material of the bottom is soft mud. The estimated cost of this work was $173,500.

Seventy thousand dollars have been appropriated for this work, of which $68,979.74 have been expended.

The dike on the west side of the channel has been built 3,057 feet long.

During the past fiscal year the channel leading up the bay and creek to Flushing has been widened to 200 feet for a length of 2,400 feet, and a branch channel 1,450 feet long and 55 feet wide dredged to the steamboat landing at the head of the bay.

Thirty-five thousand dollars could be profitably expended during the ensuing fiscal year in extending the dikes and maintaining the channel depth.

July 1, 1887, amount available	$5,201.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,181.12
July 1, 1888, balance available	1,020.26
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,020.26

Amount (estimated) required for completion of existing project	88,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D 21.)

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22. *Removing sunken vessels or crafts obstructing or endangering navigation.*—The contract for removal of the wreck of the sloop-scow *George C. Bloomer*, sunk in the Connecticut River, at Hartford Conn., which was in force at the date of the last annual report, was completed during the summer of 1887; the wreck was entirely removed.

Under section 4 of act of Congress approved June 14, 1880, notice to owners of the schooner *R. H. Daly*, wrecked and sunk in the Connecticut River, near Saybrook Point, Conn., was duly published; subsequently arrangement for her removal was made, and the work was done in December, 1887.

Under the same law, the wreck of the *Louise Bliss* was removed in December, 1887, after publishing the required notice to owners. This vessel was a three-masted schooner, wrecked and sunk in November, 1885, in the west end of Long Sand Shoal, Long Island Sound, about 6 miles southwest from the mouth of the Connecticut River.

April 14, 1887, the schooner *Emma J. Higgins* was wrecked and sunk in about 11 fathoms of water about 6 miles southwest of Black Rock Harbor, Connecticut; her spars were broken off about low-water level and were a source of danger to vessels navigating that part of the sound. Under the same law, after duly publishing notice to owners, the spars of this vessel were removed, so as to make a clear depth of more than 25 feet over the wreck.

(See Appendix D 23.)

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY.

Officer in charge, Lieut. Col. Walker McFarland, Corps of Engineers, having under his immediate orders Capt. George McC. Derby, Corps of Engineers. These works were in temporary charge of Lieut. Col. G. L. Gillespie, Corps of Engineers, from January 1, 1888, to June 29, 1888.

1. *Hudson River, New York.*—The improvement of this river has been restricted by the wording of the appropriation acts to that part of it lying between Troy, at the head of navigation, 6 miles above Albany, and New Baltimore, about 14 miles below Albany.

Before the improvement was begun the navigable depth in the channel between New Baltimore and Albany was 7½ feet at mean low water; between Albany and Troy, 4 feet.

The plan of improvement adopted in 1867 proposed making the navigable depth between New Baltimore and Albany 11 feet, and between Albany and Troy 9 feet. This was to be accomplished by the construction of longitudinal dikes to direct the currents and by dredging.

All the dikes provided for in this plan have not yet been built, but the work so far done has resulted in securing a channel depth of 10 feet nearly all the way from New Baltimore to Albany, and of 8 feet nearly all the way from Albany to Troy. The shoal spots make the navigable depths in those parts of the river 9½ feet and 7½ feet, respectively.

The estimated cost of making this improvement as modified subsequently was $1,078,304, and the appropriations amount to $1,053,538.

A large part of this amount has, however, from the necessity of the case, been applied to the repair of decaying dikes instead of to the construction of the new dikes yet to be built.

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A close examination of the works made within the past year shows that—

The completion of the new works required and the removal of the rock at Van Wie's Point will cost probably	$120,000
And the repair of the old works below Albany	103,000
And the repair of the old works above Albany	37,000
Total	260,000

These last are rapidly deteriorating and need immediate repair in order to prevent great injury to the channel.

During the past year the repairs at the West Dike at New Baltimore, the Roah Hook Dike, and the Middle Dike at Coeymans have been completed.

July 1, 1887, amount available	$23,018.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,560.22
July 1, 1888, balance available	21,458.28
Amount appropriated by act of August 11, 1888	75,000.00
Amount available for fiscal year ending June 30, 1889	96,458.28
Amount (estimated) required for completion of existing project	185,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 1.)

2. *Harbor at Saugerties, New York.*—This harbor is formed by the mouth of Esopus Creek, which empties into the Hudson River on the west bank, about 100 miles above New York.

The plan of improvement which has been adopted for it provides for securing a channel depth of 8 feet at mean low water by the construction of two parallel dikes about 300 feet apart, curved slightly downstream at the outer ends, and by dredging between them, if necessary.

The estimated cost of this improvement is $52,000, of which $20,000 have been already appropriated. During the past year the south dike, 2,363½ feet long, has been built at a cost of $16,048.16.

July 1, 1887, amount available		$19,939.95
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,303.09	
July 1, 1888, outstanding liabilities	3,938.17	
		17,241.26
July 1, 1888, balance available		2,698.69
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		14,698.69
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 2.)

3. *Harbor at Rondout, New York.*—This harbor lies at the mouth of Rondout Creek, about 90 miles above New York, on the west side of the Hudson River. The project for its improvement adopted in 1872 proposes to secure a channel depth of 13 feet at mean low water by means of parallel dikes and by dredging between them, the estimated cost being $172,000.

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The project was completed in 1880, the actual cost being only $90,000, since which time such small appropriations as have been made have been applied to the repair of the dikes.

The channel maintains its depth and will continue to do so until the dikes are broken through. These dikes are much decayed and ought to be replaced, and $5,000 can well be applied to this purpose during the coming year.

Work during the past year has been confined to replacing the fender piles of the north dike and repairing a couple of small breaks in it.

July 1, 1887, amount available	$2,560.36
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,409.14
July 1, 1888, balance available	151.22
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,151.22
Amount (estimated) required for repairs	5.000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 3.)

4. *Harlem River, New York.*—The Harlem River and Spuyten Duyvil Creek are both included in this improvement, and at present the former is navigable for vessels of 12 feet draught to Morris Dock, about 6 miles from its junction with the East River; the latter for about 1¾ miles from the Hudson for vessels of 8 feet draught and only at high water. The object of the improvement is to make a channel connecting these two streams, so that vessels may pass through from the East River to the Hudson, and the principal work is the cut which is to connect them. Though there is an interchange of waters now to some extent, there is no navigable channel except for row-boats.

The project for the improvement was originally adopted in 1875, and was for a channel 350 feet wide and 15 feet deep at mean low water. In 1879 the width of the channel was changed to 400 feet, except in the rock-cut through Dyckman's Meadow, where, owing to the large increase of the cost if a change were made, the width was to be restricted to 350 feet, but the depth was to be increased to 18 feet at mean low water.

The amount expended upon the improvement up to the close of the fiscal year ending June 30, 1887, was $987.77.

As the appropriations, though made June 18, 1878, and March 3, 1879, were not available until May 3, 1887, owing to the delay produced by the legal proceedings for the acquirement of the land, the condition of the streams remained the same as before the project for the improvement was adopted.

During the fiscal year ending June 30, 1888, there has been expended $41,179.68 on the cut through Dyckman's Meadow, for engineering experiments in structures for protecting the sides of the channel, and for boring to determine the nature of the substrata on the marsh. When the present contract is completed, about 700 feet of the channel through Dyckman's Meadow will be finished to the width of 350 feet and depth of 18 feet at mean low water.

The amount that can be profitably expended during the year ending June 30, 1890, is $500,000, and would be applied to excavating the channel through the marsh between Dyckman's Meadow and the Hud-

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son River, and to structures for protecting the sides and probably the bottom of the new channel.

The estimated amount required for the completion of the work according to the present approved project is $2,309,000.

July 1, 1887, amount available		$399,012.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$41,179.68	
July 1, 1888, outstanding liabilities	18,288.07	
July 1, 1888, amount covered by existing contracts	268,261.76	
		327,729.51
July 1, 1888, balance available		71,282.72
Amount appropriated by act of August 11, 1888		70,000.00
Amount available for fiscal year ending June 30, 1889		141,282.72
Amount (estimated) required for completion of existing project		2,230,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 4.)

5. *Removing obstructions in the East River and Hell Gate, New York.*—Hell Gate is the worst obstruction in the narrow strait connecting Long Island Sound with New York Harbor, known as the East River.

At this point the channel turns at right angles around Hallet's Point, opposite the mouth of the Harlem River, and the curren' runs with a velocity varying at different stages of the tide from 3 to 10 miles an hour over or around Way's Reef, Pot Rock, Shell Drake, Hallet's Point, Negro Point, Holmes Rock, Hog's Back, Heel Tap, Flood Rock, Hen and Chickens, Gridiron, Mill Rocks, The Negro Heads, Rhinelander's Reef, and Bread and Cheese.

Besides this most serious obstruction there are many other rocks and reefs in the East River, especially those off Thirty-fourth street and Ninth street, which are dangerous to its crowded navigation, and which ought to be removed.

The plan of improvement adopted some years ago proposed the building of sea-walls over some of these rocks, and the reduction of others to a depth of 26 feet below mean low water.

In accordance with this plan, Diamond Reef, near Governor's Island, Coenties Reef, off Coenties Slip, Pilgrim Rock, off Nineteenth street, and a reef near the North Brother Island have been cut down, and at Hell Gate 3 acres of Hallet's Point have been removed to the required depth; Pot Rock has been cut down to 23 feet below mean low water, Frying Pan to 18 feet, and Heel Tap to 21 feet; while Flood Rock, covering 9 acres and including the Negro Heads, Hen and Chickens, and Gridiron, has been blown up and nearly one quarter of it removed. Sea-walls have been built by the Government on Great and Little Mill Rocks, and by the city authorities on Bread and Cheese Reef. The work of removing rock at Hallet's Point and Flood Rock has been done by mining, and at the other points by the United States steam-drill scow.

During the past year the only work done was the removal of 19,548 tons of rock by contract from Flood Rock, which resulted in increasing by 60 feet the width of the Newton Channel lying between Flood Rock and Mill Rocks.

The work of removing the wreck of Flood Rock and the other rocks

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mentioned both in Hell Gate and in the East River ought to be continued, and $500,000 could be profitably expended next year in this way.

July 1, 1887, amount available		$24,717.62
Received from sales of fuel to officers		52.49
		24,770.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,301.95	
July 1, 1888, outstanding liabilities	383.00	
		8,684.95
July 1, 1888, balance available		16,085.16
Amount appropriated by act of August 11, 1888		250,000.00
Amount available for fiscal year ending June 30, 1889		266,085.16
Amount (estimated) required for completion of existing project		1,238,840.67
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 5.)

6. *Newtown Creek, New York.*—This is a small tidal stream, about 4 miles long, running through the eastern part of Brooklyn and emptying into the East River opposite Thirty-fourth street, New York City.

It had formerly a depth of 12½ feet at the mouth, gradually decreasing to 4 feet at the head.

Its present condition shows a depth of 18 feet at the mouth, and from 8½ to 10 feet at the head.

The original project for its improvement adopted in 1880, but modified in 1884, provided for a channel 240 feet wide and 21 feet deep, extending from the mouth up to Vernon Avenue Bridge; and from that point up to the head of navigation, on both branches, a channel decreasing from 175 to 100 feet in width and from 18 to 10 feet in depth.

Work during the fiscal year has been confined to dredging an 18-foot channel below Vernon Avenue Bridge, and a 10-foot channel at the head of navigation on both branches of the creek above Maspeth avenue.

No permanent benefit can be derived from dredging in the upper part of the creek until the banks, composed of soft mud, are protected by bulkheads, since the material washes into the dredged channels.

The commerce of the creek is very large.

July 1, 1887, amount available	$2,577.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,034.40
July 1, 1888, balance available	1,542.83
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	26,542.83
Amount (estimated) required for completion of existing project	148,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 6.)

7. *Buttermilk Channel, New York Harbor.*—This channel lies between the city of Brooklyn, New York, and Governor's Island, New York Harbor, and is obstructed at its upper end, where it joins the East River, by a shoal over which there was formerly a least depth of 9½ feet at

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mean low water. The crest of this shoal lay about 800 feet outside the line of the Brooklyn wharves.

The original project of improvement, adopted in 1881, provided for the removal to a depth of 26 feet at mean low water of such parts of the shoal as came within 850 feet of the Brooklyn wharves, which would take off the crest of the shoal, and ought to give nowhere a depth of less than 15 feet water on it.

The estimated cost of the improvement was $210,000, of which $190,000 had been appropriated up to June 30, 1886.

With this the channel has been widened to the full width proposed, and deepened to not less than 24, and probably 26, feet at mean low water; but this is not certain, as no survey has been made since 1884.

In view of the increasing importance of the wharves on the Brooklyn shore, and the difficulty experienced by deep-draught vessels in getting up to them by reason of this shoal, it was recommended in 1885 that the whole shoal be removed to a depth of 26 feet, and this recommendation was tacitly approved by Congress by the act of August 5, 1886, which appropriated $56,250 for this purpose. This amount not being sufficient, however, to cut the whole down to a depth of 26 feet at mean low water, it was decided to cut it down to 22 feet, leaving the additional depth of 4 feet to be got under future appropriations.

Under this appropriation the whole shoal was removed to a depth of 22 feet at mean low water.

This has already proved a benefit to navigation; but, in view of the large passing commerce, it is very desirable to give the full depth of 26 feet.

July 1, 1887, amount available	$9,461.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,604.78
July 1, 1888, balance available	5,857.16
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	105,857.16

(See Appendix E 7.)

8. *Gowanus Bay, New York.*—The depth of water in the channels of Gowanus Creek and Bay was originally only from 7 to 12 feet at mean low water, which was wholly insufficient for the passage of vessels employed in the commerce of the district.

The plan of improvement, adopted in 1881, provided for giving a depth of 18 feet to the channels in the bay leading up to the mouth of the creek on both the north and south sides, and for carrying the improvement with the same depth up the creek to Hamilton Avenue Bridge, a distance of about 1 mile.

The channel widths were to be 200 feet, except for the last few hundred feet up to the bridge, in which distance the width would gradually decrease.

The estimated cost of this improvement was $192,564.90, of which $65,000 had been appropriated up to June 30, 1886. With this money the northern channel leading up to the creek had been completed, and the dredging carried on up the creek to within 2,100 feet of Hamilton Avenue Bridge; and the southern channel had been dredged to within 2,000 feet of the mouth of the creek.

The act of August 5, 1886, appropriated $7,500 for the improvement. This was applied to dredging a channel 1,500 long and 40 feet wide at bottom, from the end of the last dredging in the creek up towards Ham-

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ilton Avenue Bridge. The depth obtained was 18 feet, but owing to the softness of the material it has since filled in to 15 feet.

The rates of wharfage in New York Harbor are now so high that the necessity for getting additional wharf room has become imperative, and nowhere can it be so easily had as in Gowanus Bay.

Eventually the channels here must be made both wider and deeper than they will be under the present plan of improvement, but for the present they should be deepened to 18 feet.

No work has been done during the present fiscal year, owing to the want of funds.

July 1, 1887, amount available	$64.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1.00
July 1, 1888, balance available	63.31
Amount appropriated by act of August 11, 1888	60,000.00
Amount available for fiscal year ending June 30, 1889	60,063.31
Amount (estimated) required for completion of existing project	60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 8.)

9. *New York Harbor.*—Before the improvement of the main entrance into New York Harbor was undertaken by the United States, the least depth in mid-channel on the bar was 23.7 feet, at mean low water, and the same depth could be carried across three other shoals between the bar and deep water in the harbor.

A large proportion of the vast commerce of the port which is carried on in vessels of great draught could only cross these shoals at, or near, high water.

The project for the improvement of Gedney's Channel was approved by the Secretary of War in December, 1884, and its extension to cover the whole of the main entrance to the harbor received his approval December 27, 1886.

It provides for dredging a channel 1,000 feet wide and 30 feet deep at mean low water, from deep water below the Narrows through the Main Ship Channel and Gedney's Channel to deep water outside the bar; maintaining this channel, should it be necessary, either by periodical dredging, or by contracting the entrance by the construction of a dike running across the shoals from Coney Island side, with suitable protection for the head of Sandy Hook to prevent its being scoured away by the increased current.

The estimated cost of obtaining the dredged channel is $1,490,000 for dredging 4,300,000 cubic yards; and the entire cost of the improvement, should the contraction works prove to be necessary, is estimated at between $5,000,000 and $6,000,000.

Under this project an extended survey of the lower bay had been made on which the method of improvement was based, and 303,869 cubic yards of sand had been dredged from Gedney's Channel at the close of the last fiscal year.

This had resulted in producing a channel of good navigable width across the bar 25 feet deep at mean low water; but no practical benefit to navigation had resulted, since no increase in depth had been obtained on the shoals inside the bar; the application of the funds having been restricted by the language of the appropriation act to Gedney's Channel only.

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During the past fiscal year both the bar and the inner shoals have been dredged under contract with the Joseph Edwards Dredging Company, and 580,405 cubic yards of sand and mud have been removed at 28½ cents per cubic yard. A channel has been obtained not less than 500 feet wide in which the least depths between the steamer wharves and the ocean, is 26 feet on the bar, and 25.4 feet on the shoal west of Flynn's Knoll in the lower bay.

These dimensions are sufficient to enable the largest steamers arriving off the bar as now loaded to reach their wharves without delay at average low tide; and they also permit any of the large steamers leaving the port at high water, as is usual, to go to sea loaded fully 2 feet deeper than was ever practicable before.

The dredged channels have been thoroughly buoyed, and as soon as the pilots have become familiar with the new channels the port of New York will reap the full benefit of the results.

Surveys made in December, 1887, and May, 1888, show that no shoaling whatever had taken place on the bar in the interval of six months during which no dredging was done there. As a like comparison was made a year ago with precisely the same result, there are good grounds for expecting that the dredged channel across the bar may maintain its new dimensions by the action of the currents alone.

Arrangements have been made for increasing the number of dredges at work on the shoals, and it is expected that the existing contracts for the removal of 2,200,000 cubic yards will be completed at the time specified, December 1, 1888.

The amount needed outside of the present appropriation to widen these channels to 1,000 feet, and to deepen them to 30 feet at mean low water as required by the plan of improvement, is $160,000; and this amount could be well expended in the next fiscal year.

July 1, 1887, amount available		$742,293.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$137,714.37	
July 1, 1888, outstanding liabilities	60,467.95	
July 1, 1888, amount covered by existing contracts	461,586.27	
		659,768.59
July 1, 1888, balance available		82,524.68
Amount appropriated by act of August 11, 1888		380,000.00
Amount available for fiscal year ending June 30, 1889		462,524.68
Amount that can be profitably expended in fiscal year ending June 30, 1890		160,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 9.)

10. *Sheepshead Bay, New York.*—The project for the improvement of this bay, adopted in 1879, provided for maintaining the natural outlet of the bay into Rockaway Inlet by means of diking and dredging, and for contracting the water-way in the bay above the entrance by means of dikes so as to afford a channel 6 feet deep up to the head of navigation, about 2 miles above the mouth.

The depth of water at the mouth was about 2 feet, but the channel was uncertain and shifting.

The estimated cost of the improvement was $100,000.

A resurvey was made in 1882, when the old outlet was found to be nearly closed up, and it was then proposed to cut a new outlet 6 feet deep and 100 feet wide north of the old one into Dead-Horse Inlet, and

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to dredge the interior channels of the bay to a depth of 6 feet at mean low water.

The estimated cost of this was $34,200, of which $16,000 had been appropriated up to June 30, 1886.

After some correspondence and delay the new outlet was excavated and protected on the north side by a bulkhead built partly by the property owners and partly by the contractor who was doing the dredging for the Government.

The present appropriation will be applied to deepening the channel through the bay, though no permanent good can result from it.

The navigation of the bay is restricted almost entirely to pleasure boats used by the Coney Island and Gravesend Bay hotels, and there seems to be no present necessity for further appropriations for this improvement.

July 1, 1887, amount available	$5,283.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	166.17
July 1, 1888, balance available	5,117.56
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	10,117.56
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,200.00

(See Appendix E 10.)

11. *Canarsie Bay, New York.*—The plan of improvement adopted for this harbor in 1879 proposed to obtain a channel 6 feet deep at mean low water by means of diking and dredging from the 6-foot curve in Jamaica Bay up to the Canarsie Dock, a distance of about 3,500 feet.

The estimated cost of this improvement was $88,000, of which $33,000 have been appropriated up to the close of the fiscal year ending June 30, 1888. With this amount a pile-dike 1,150 feet long has been built on the north side of the outer end of the channel, and a channel from 5 to 6 feet deep and from 50 to 125 feet wide has been kept open from the 6-foot curve in Jamaica Bay up to the dock at Canarsie Landing.

The appropriation of August 5, 1886, has been applied during the fiscal year to dredging three shoals in the channel, and to beginning the construction of 850 linear feet of the south dike, which work is still in progress.

As the channel can not be regarded as secure before the south dike is completed, it is recommended that $10,000 be appropriated for this purpose and for such dredging as may become necessary.

July 1, 1887, amount available		$10,066.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,630.38	
July 1, 1888, amount covered by existing contracts	8,389.50	
		10,019.88
July 1, 1888, balance available		46.87
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,046.87
Amount (estimated) required for completion of existing project		45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E 11.)

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12. *Sumpawanus Inlet, New York.*—The project for the improvement of this inlet, known locally as Sumpwams Creek, adopted in 1880, provided for dredging a channel about 4,500 feet long, and from 100 to 150 feet wide and 5 feet deep at mean low water, beginning at the 5-foot curve in the Great South Bay and extending up to the town of Babylon, Long Island.

The channel depth at the time of the adoption of the project varied from 5 feet in the bay at mean low water to 2 feet at the wharf at the mouth of the creek, and from 1 to 2 feet up the creek a distance of a little over half a mile.

The rise and fall of the tide is so slight here that there is no scour in the channel; nor could an efficient scour be obtained by contracting the channel width.

Therefore, it was decided to get the channel desired by dredging from the deeper waters of the bay up to the steam-boat wharf at the mouth of the creek, a distance of 1,500 feet, and thence up the creek for a distance of about 3,500 feet; the estimated cost being $23,115.

Seven thousand dollars was applied towards obtaining a channel up to the steam-boat wharf, but shoaling has occurred since the work was done in 1883. The commerce of the town of Babylon, which lies on the creek, is almost entirely moved now by rail, and there appears to be little reason for restoring or completing the channel to the steam-boat wharf at the mouth of the creek, and none whatever for constructing it up to Babylon, two-thirds of a mile above.

The river and harbor act of August 11, 1888, contains no appropriation for this work.

July 1, 1887, amount available	$81.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10.00
July 1, 1888, balance available	71.88
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,000.00

(See Appendix E 12.)

13. *Channel between Staten Island and New Jersey.*—The improvement of this channel, so far, has been restricted to that part of it about 1¾ miles long which lies east of Elizabethport, N. J., and at the mouth of Newark Bay.

This part of the channel had formerly a depth of only 9½ feet in it at mean low water; at present it has a depth of not less than 13 feet for widths varying from 300 to 400 feet.

The present project for its improvment is a modification of that proposed in 1876, and provides for obtaining a channel 400 feet wide and 13 feet deep at mean low water, by means of dredging and, if necessary, diking, the estimated cost being $210,000. Of this amount $119,000 have been already appropriated.

Work during the fiscal year has been confined to widening the eastern and western ends of the channel to 400 feet.

July 1, 1887, amount available	$1,926.25
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,115.65
July 1, 1888, balance available	810.60
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,810.60

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Amount (estimated) required for completion of existing project	$76,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 13.)

14. *Raritan Bay, New Jersey.*—The project of improvement now being executed provides for opening a channel from Ward's Point, opposite Perth Amboy, N. J., past Seguine's Point, Staten Island, and out into the deep water of the Lower Bay of New York. The channel to be 21 feet deep at mean low water and 300 feet wide. Also a channel leading from this up to the wharves of South Amboy, 15 feet deep at mean low water and 300 feet wide.

Work previous to 1887 was confined to dredging a 21 foot channel through the shoal east of Seguine's Point; but the channel has filled in materially again during the last three years.

During the past fiscal year it was expected to obtain a 21-foot channel from Ward's Point past Great Beds Light; but the channel was found to be shoaler than had been anticipated, and the funds were not sufficient to complete it.

The channel leading to South Amboy has not been begun.

To complete the project of improvement, the whole balance of the original estimates of last year, namely, $57,500, will be needed.

July 1, 1887, amount available		$37,579.03
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$33,636.18	
July 1, 1888, outstanding liabilities	2,935.13	
		36,571.31
July 1, 1888, balance available		1,007.72
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		26,007.72

Amount (estimated) required for completion of existing project	57,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	47,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E 14.)

15. *Removing sunken vessels or craft obstructing or endangering navigation.*—(1) *Sloop Locomotive.*—Hudson River. This sloop, sunk in the Hudson River, off Saugerties, N. Y., in August, 1887, was removed at a cost of $317.94, by hired labor, October 27 and 28, 1887.

(2) *Bark Quickstep.*—New York Harbor. This vessel was wrecked on the west side of the main ship-channel, New York Harbor, in 1887, and was removed under contract, at a cost of $3,200, during the fiscal year.

(3) *Wreck of a canal-boat in Harlem River near High Bridge.*—The wreck was removed at a cost of $175, by the Baxter Wrecking Company, during December, 1887, and January, 1888.

(See Appendix E 15.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

The required preliminary examination of *Spring Creek, New York*, was made by the local engineer, Lieutenant-Colonel McFarland, and reported by him as not worthy of improvement. The results were transmitted to Congress and printed as House Ex. Doc. No. 70, Fiftieth Congress, second session. (See also Appendix E 16.)

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It appearing, after preliminary examination by the local engineer, that the locality was worthy of improvement, Lieutenant-Colonel Gillespie completed the survey of *Hudson River, New York, between New Baltimore and Coxsackie*, the results of which were transmitted to Congress and printed as House Ex. Doc. 265, Fiftieth Congress, first session. (See also Appendix E 17.)

IMPROVEMENT OF RIVERS IN NORTHERN NEW JERSEY, AND OF THE HARBOR OF KEYPORT.

Officer in charge, Capt. George McC. Derby, Corps of Engineers.

1. *Passaic River, New Jersey.*—This river is being improved under two separate projects, the first applying to the river above Center street, or Pennsylvania Railroad Bridge, Newark, as far as Passaic, a distance of 8 miles, and the second to the lower course of the river, from the Center Street Bridge to beyond the shoals in Newark Bay, a distance of $7\frac{5}{8}$ miles.

a. Passaic River, above Newark.– Before its improvement was undertaken, the upper part of the river had a navigable 6-foot channel, except at Middle, Belleville, Rutherford Park, and Holzman's Bars, where the depths were 4.5 feet, 3.9 feet, 3 feet, and 3.5 feet, respectively.

The project of improvement was adopted in 1872, and provided for a channel across the above shoals from $7\frac{1}{2}$ to 6 feet deep at mean low water, and from 200 to 50 feet wide, to be obtained by dredging and diking, at a cost of $123,924. It was modified in 1885, by extending the channel, below Middle Bar, 1,500 feet, to the Erie Railroad Bridge, increasing the estimate to $129,000.

Under this project $123,762.04 had been expended to June 30, 1887, and channels of the required depth had been dredged from 60 to 75 feet wide, excepting for a distance of 1,500 feet above the Erie Railroad Bridge.

There has been no work done on the upper river during the fiscal year, no method of applying efficiently the small allotment of $2,250 made by the act of August 5, 1886, having been found. The condition of the river remains unchanged.

The population of the townships on the Passaic, above Newark, including the city of Paterson, was returned in 1885 as 114,726, and the commerce of the upper river was valued in 1884 at $1,032,000. The number of vessels passing the Center Street Draw-bridge during the year 1887 has been 10,040, compared with 9,485 in 1886 and 6,271 in 1879.

The expenditures during the year have been for draughting (old records) and administration.

The balance of the estimate for the completion of the existing project, $7,512, can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and if appropriated will be expended in dredging the channels to the dimensions required by the project.

July 1, 1887, amount available	$2,487.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	345.50
July 1, 1888, balance available	2,142.46
Amount appropriated by act of August 11, 1888	7,500.00
Amount available for fiscal year ending June 30, 1889	9,642.46

(See Appendix F 1.)

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b. Passaic River, below Newark.—The lower portion of the river, from the Center Street Bridge to Newark Bay, was first surveyed by the Engineer Department in 1879. The greatest depth in the channel, at a point above the Elbow Beacon, was only 7.1 feet, and in many places the greatest depth was 7.5 feet at mean low water.

A project was adopted, based on this survey, providing for obtaining, by diking and dredging, a channel 200 feet wide and 10 feet deep at mean low water from the Center Street Bridge to Newark Bay, at a cost of $232,875.

This project was modified in 1884, pursuant to the river and harbor act of that year, providing for extending the dike at the mouth of the river into the bay a distance of 8,000 feet, and for dredging a channel across the shoal in Newark Bay 200 feet wide and 10 feet deep at mean low water, increasing the original estimate to $353,875.

June 30, 1887, $149,223.60, exclusive of outstanding liabilities, had been expended under this project; the dike at the mouth had been extended about 1,700 feet, making a total length of 5,705 feet. The channel through the shoal in the bay had been dredged to the required dimensions, as also the channel up the river, as far as the Newark and New York Railroad Bridge. The remainder of the distance to the Center Street Bridge, the 10-foot channel had only been dredged from 130 to 100 feet in width. These results had been of very great benefit to the large commerce of the river, which was estimated in 1884 at 1,200,000 tons, valued at $30,000,000.

The contract for the extension of the dike at the mouth of the river was completed September 7; 500.3 feet of dike were constructed during the fiscal year, making the total length of the dike 6,205 feet.

The expenditures during the year amount to $1,782.25, for construction and inspection of dike, surveying, and administration.

July 1, 1887, amount available		$4,895.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,603.25	
July 1, 1888, outstanding liabilities	179.00	
		1,782.25
July 1, 1888, balance available		3,113.15
Amount appropriated by act of August 11, 1888		27,500.00
Amount available for fiscal year ending June 30, 1889		30,613.15
Amount (estimated) required for completion of existing project		154,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F 1.)

2. *Elizabeth River, New Jersey.*—This stream, which is $2\frac{5}{8}$ miles from its mouth to the head of navigation at Broad street, Elizabeth, has a width of from 50 to 90 feet, and before its improvement the wharves in the city could only be reached at high water by vessels drawing less than 4 feet; its commerce was estimated at 45,000 tons annually. The range of the tide was about 4.7 feet at its mouth, and 3.4 feet at Bridge street.

The project for the improvement was adopted in 1878, and provides for obtaining, by dredging, a channel 60 feet wide and 7 feet deep at high water from the mouth of the river to the head of navigation, at an estimated cost of $25,530.

The amount expended under this project to June 30, 1887, was $26,708.66, and a channel had been dredged to the required depth to

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within 1,000 feet of the Broad Street Bridge. A slight increase in the commerce of the stream had been observed.

There has been no appropriation for this work since 1882. The condition of the river has deteriorated since work was suspended. When last examined vessels drawing 5 feet could ascend the river to the head of the dredged channel at high tide. The commerce of the river is about 30,000 tons, but no substantial increase can be expected while the river remains in its present condition. A coal-yard established last year has done a business of about 6,000 tons.

The city of Elizabeth has a population of about 33,000, and does an active commerce over two important lines of railroad, a considerable portion of which would take the water route, to great advantage, if adequate facilities existed. It is stated that the establishment of the coal-yard on the river has reduced the retail price of coal 50 cents per ton.

The estimated amount required for the completion of the improvement is $16,160.

July 1, 1887, amount available	$291.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	13.08
July 1, 1888, balance available	278.26
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,160.00

(See Appendix F 2.)

3. *Rahway River, New Jersey.*—In its original condition the Rahway River had a depth of 8 feet and more at mean high water from its mouth to Bricktown, 3⅝ miles; 7 feet to Edgar's Dock, 4⅛ miles; 4.4 feet to Milton Avenue Bridge, 4¾ miles; and 4 feet to Main Street Bridge, 5 miles in the town of Rahway. Its commerce was estimated at 120,000 tons, and three attempts had been made to establish a line of steam-boats on the river, but had failed on account of the bad condition of the stream.

The original project for its improvement was adopted in 1878, and provided for dredging a channel 125 feet wide and 8 feet deep at high water from Bricktown to Milton Avenue Bridge, and 100 feet wide from that point to Main Street Bridge. The tide rises about 5 feet at the mouth and 4 feet at the head of navigation.

June 30, 1887, $36,918.13 had been expended under this project, which had resulted in the formation of a channel 7 feet deep at high water, and from 100 to 50 feet in width to within 550 feet of the head of navigation. It has, however, not proved permanent.

The commerce of the river had not increased, though freight rates to Rahway had been materially reduced as a result of the improvement of the river.

There has been no appropriation for this work since 1882.

July 1, 1887, amount available	$81.87
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14.20
July 1, 1888, balance available	67.67
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	29,250.00

(See Appendix F 3.)

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4. *Woodbridge Creek, New Jersey.*—In its original condition this stream was obstructed at its mouth by a bar having a depth of 9.8 feet on its crest at high water, and by two shoals just inside the mouth. From these shoals a good 12-foot channel existed to above Anderson's Brick Works, seven-eighths of a mile from the mouth, above which point, however, many shoals occurred, though a narrow 8-foot channel existed as far as Salamander Dock, 1⅞ miles from the mouth. The town of Woodbridge, and numerous fire-brick, tile, and drain-pipe works, situated on the creek, did a considerable trade, estimated at 126,000 tons annually. The range of the tide is about 5 feet.

The project for improving the creek was adopted in 1878, and provides for obtaining by dredging and diking a channel 80 feet wide and 12 feet deep at mean high water from the mouth to Salamander Dock, at an estimated cost of $13,800, increased in 1884 to $29,000.

The amount expended under this project to June 30, 1887, was $19,000, with which the required dike had been constructed, and a 12-foot channel, from 80 to 25 feet wide, had been obtained as far as Valentine's Dock, 1⅝ miles, and a 9-foot channel 80 feet wide thence to Town Dock, 1,200 feet further up; and the creek was also widened 20 feet at the elbow opposite Salamander Dock. No increase in the commerce of the creek had been observed.

There has been no appropriation for this work since 1882; there were no funds available during the last fiscal year, and no expenditures. The condition of the channel has deteriorated since work was suspended, and shoals are complained of both above and below Valentine's Dock. There has been no increase in the amount of commerce reported above, which is already very large in proportion to the size of the stream.

Amount (estimated) required for completion of existing project..... $10, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F 4.)

5. *Raritan River, New Jersey.*—Before its improvement by the United States, the Raritan River had a depth of 8.5 feet at "The Stakes," 3 miles; of 6.5 feet at the "Middle Grounds," 4¼ miles; of 7.5 feet at Whitehead's Sand Dock, 8½ miles, and between this point and New Brunswick, 12¼ miles above the mouth, the channel was obstructed by a number of rocky shoals with depths of from 8.4 feet to 6.9 feet at mean low water. The city of New Brunswick and the Delaware and Raritan Canal, which terminates here, together with extensive brick-yards on the South River, did a large commerce on the stream, estimated in 1871 at 3,053,857 tons per annum.

The present project was adopted in 1874, and provides for obtaining, by diking and dredging, and where necessary, by drilling and blasting rock, a channel 200 feet wide and 10 feet deep at mean low water, from the mouth to New Brunswick, at a cost of $2,093,662.05. It was modified in 1881, pursuant to the river and harbor act of March 3 of that year, by adding to it the dredging of the South Channel, about 13,000 feet long, 100 feet wide, and 5½ feet deep at mean low water, from Kearney's Dock to Crab Island.

Under this project $447,638.57 had been expended June 30, 1887, in constructing the dikes required by the project at "The Stakes" and "Middle Grounds," in dredging channnels 200 feet wide and 12 feet deep at mean low water at these points, and in drilling, blasting and dredging a channel of the same dimensions across the rocky shoal at Whitehead's Sand Dock. Under the two special allotments made for it

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in the acts of March 3, 1881, and August 2, 1882, the South Channel was dredged to the required depth for a distance of 4,000 feet. These improvements have been of great benefit to navigation, permitting the large tows in use on the river to reach a point 4 miles below New Brunswick at all stages of the tide.

The expenditures during the fiscal year amount to $9,082.05.

The rock-drilling plant has been put in good working order, surveys have been made of the shoal below Martin's Dock, and dredging has been begun on the lower shoal.

The balance now available will be expended this season in extending the 10-foot channel to Martin's Dock, 1⅞ miles below New Brunswick, and in constructing a dike at the "Middle Grounds."

July 1, 1887, amount available		$23,651.91
Amount received from Captain Derby for sale of fuel (March 31 and June 29, 1888)		2.00
		23,653.91
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,896.49	
July 1, 1888, outstanding liabilities	185.56	
		9,082.05
July 1, 1888, balance available		14,571.86
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		64,571.86

Amount (estimated) required for completion of existing project	1,572,412.05
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 5.)

6. *South River, New Jersey.*—Before the improvement of this stream was undertaken by the United States the navigation of the lower 2½ miles of its course had been abandoned, and a canal dredged at private expense, from a short distance below Washington to Sayreville on the Raritan River. In 1880, when the present project for improving the river was adopted, the mouth of this canal on account of its faulty location had shoaled to a depth of 4.6 feet at mean low water, and the best depth in the canal some distance above had decreased to 3.3 feet. Above Washington a depth of 2.7 feet existed to Bissett's, 3⅝ miles, and of 2.5 feet to Old Bridge, the head of navigation, 6¼ miles above the mouth of the canal at Sayreville.

The present project adopted in 1880 provides for closing the river below the head of the canal, correcting the direction of the mouth of the latter, and obtaining by diking and dredging a depth of 8 feet mean low water to Washington, 6 feet to Bissett's, and 4 feet to Old Bridge, straightening the channel at two points by cutting across the meadow; it was estimated to cost $194,695.

The amount expended under this project to June 30, 1887, was $55,863.31, exclusive of outstanding liabilities, with which the direction of the mouth of the canal had been changed, the dikes below Washington completed, and a small amount of dredging done on a shoal above Washington.

During the last fiscal year the funds available have been expended, a shoal at the mouth of Washington Canal has been removed, and a channel dredged 60 feet wide through the canal and 50 feet wide across

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the shoal in the river below Washington. Vessels drawing 6 feet can reach Washington at mean low water.

July 1, 1887, amount available	$5,111.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,820.09
July 1, 1888, balance available	291.66
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,291.66
Amount (estimated) required for completion of existing project	128,695.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 6.)

7. *Cheesequakes Creek, New Jersey.*—In its original condition the stream was obstructed at its mouth by a sand-bar, on which the best depth was 1 foot at mean low water; for about a mile of its length the channel had a depth of 6 feet, but the remainder had generally a depth of 3 feet and less. The range of the tide is 5.1 feet. Five hundred and forty-six small vessels passed the draw at the mouth of the creek in 1878.

The project for this improvement was adopted in 1879, and provides for obtaining by dredging and diking a channel 5 feet deep at mean low water, and 200 feet wide, at the mouth of the creek, and 4 feet deep with a width of from 100 to 50 feet to the head of navigation at Whitehead's Dock, 3 miles from the mouth.

The amount expended under this project to June 30, 1887, was $40,000; the least depth in the improved channel at the mouth was 4.5 feet at mean low water; no work had been done on the shoals above, and no increase in the commerce of the creek had been observed.

There have been no funds available during the year ending June 30, 1888, and no expenditures. The condition of the creek and its traffic remain substantially unchanged.

The river and harbor act of August 11, 1888, contains no appropriation for this work.

The estimated amount required for the completion of the improvement is $50,000.

(See Appendix F 7.)

8. *Keyport Harbor, New Jersey.*—Keyport Harbor was originally accessible at low water only to vessels drawing less than 4 feet. Before its improvement was undertaken by the United States a 6-foot channel had been dredged at private expense, which had shoaled in 1872 to 5½ feet, and in 1882 to 5 feet, the range of the tide being 4.7 feet. A large commerce was carried on, however, valued at $2,932,000.

The project for the improvement was adopted in 1873, and provided for dredging a channel 4,700 feet long, 8 feet deep at mean low water, and 200 feet wide from the steam-boat dock to the 8 foot contour in Raritan Bay, at an estimated cost of $30,475. The revised estimate of 1884 was for $40,475.

The amount expended under this project to June 30, 1887, was $30,020.51, with which a channel had been dredged from the 8-foot depth in Raritan Bay to Keyport Wharf, a distance of 5,000 feet, with a width of 200 feet for the first 4,200 feet, and 160 feet for the remainder.

The river and harbor act of 1888 made no appropriation for this work.

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July 1, 1887, amount available		$454.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$22.38	
July 1, 1888, outstanding liabilities	5.00	
		27.38
July 1, 1888, balance available		427.11

Amount (estimated) required for completion of existing project 10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F 8.)

9. *Mattawan Creek, New Jersey.*—Before its improvement by the Government this small stream was obstructed at its entrance into Keyport Harbor by a mud flat, on which the best depth at the worst section was 3.1 feet at mean low water, though the 3-foot channel was too narrow and tortuous for use. Above this flat a good 4-foot channel existed to 1⅛ miles above the mouth, and thence to the steam-boat dock at Mattawan 3.5 feet, shoaling to 1.8 feet at the freight dock, 600 feet above, and 1⅞ miles from the mouth. The range of the tide is 4.7 feet. Notwithstanding the above difficulties it carried commerce valued in 1880 at $800,000.

The project for the improvment was adopted in 1881, and provides for dredging a channel 4 feet deep at mean low water, and 100 feet wide from the mouth to Winkson Creek, and thence 75 feet wide to the railroad bridge at Mattawan, 250 feet above the freight dock, at an estimated cost of $33,120.

To June 30, 1887, the amount expended under this project was $21,000, with which a channel had been dredged, giving the required depth from the mouth to the freight dock at Mattawan, with widths varying from 100 to 30 feet.

The estimated value of the commerce of the creek had increased to over $2,000,000 in 1885, amounting to 130,000 tons.

There has been no appropriation for this stream since 1882; there were no funds available for the past fiscal year, and there have been no expenditures. The condition of the stream has deteriorated since work was suspended, and complaints are made of shoaling at the mouth of the river. There has been no increase in the amount of commerce reported above, which is already very large in proportion to the facilities offered by the stream.

Amount (estimated) required for completion of existing project..... $12,120.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F 9.)

10. *Shrewsbury River, New Jersey.*—When the present project for this improvement was adopted in 1879 the river was obstructed by a number of shifting sand-bars, which had caused the complete suspension of navigation in the South Branch, and only permitted the passage of vessels engaged in commerce up the North Branch at or near high water. A considerable trade was carried on, however, even under these difficult conditions.

The originally-adopted project for the improvement was to dredge a channel 6 feet deep at mean low water and from 300 to 150 feet in width, accross the shoals from the mouth to Red Bank, on the North Branch, 8 miles, and Branchport, on the South Branch, 9 miles, maintaining these channels by longitudinal dikes. This project has not been modi-

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fied as to the end sought, but the estimates of the diking, dredging, and cost have been increased from time to time.

The amount expended on the project to June 30, 1887, was $196,933.50, exclusive of existing contracts, which had resulted in the material improvement of the river, the commerce of which had been more than trebled since the commencement of the improvement.

During the last fiscal year $3,186.43, exclusive of existing contracts, have been expended in constructing 2,564 linear feet of stone dikes at and near the junction of the North and South Branches of the river, in making tidal observations, and for administration. The condition of the river channels remains the same as last year. A depth of 5.9 feet exists on the bar at the mouth of the river at mean low water, and 5.5 feet can be carried to Red Bank and 4.4 feet to Branchport.

July 1, 1887, amount available		$7,456.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,085.08	
July 1, 1888, outstanding liabilities	101.35	
July 1, 1888, amount covered by existing contracts	2,915.95	
		6,102.38
July 1, 1888, balance available		1,354.12
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,354.12
Amount (estimated) required for completion of existing project		40,062.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix F 10.)

11. *Manasquan River, New Jersey.*—In its original condition this stream had a depth of from 6 to 4 feet at mean low water for several miles above its mouth, but was obstructed at its outlet into the ocean by a sand-spit, which had deflected the stream into a channel parallel with the beach, communicating with the ocean across shifting sand-bars, on which the best depth did not exceed 1½ feet at mean low water; mean range of tide, 2.4 feet. In severe storms this channel was sometimes entirely closed by the sand, remaining so until the fresh water in the river had accumulated sufficiently to force a new outlet. Under these conditions the river could not be used by commerce.

The project for its improvement was adopted in 1879, and contemplated dredging the lower river and obtaining by means of jetties a permanent outlet nearly at right angles to the beach, with a depth of 6 feet at mean low water, at an estimated cost of $52,120.

The amount expended on this project to June 30, 1887, was $39,000, with which two jetties had been constructed, but neither to its full length, appropriations having ceased in 1882. No permanent improvement had been effected.

There were no expenditures on account of this work during the year ending June 30, 1888, there being no funds available.

As there is no commerce on the river now, and no population or interests sufficient to support a trade at all commensurate with the cost of making the river available, it does not seem likely that it is the intention of Congress to complete this work, particularly as no appropriation has been made for it in several years.

Amount (estimated) required for completion of existing project	$33,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F 11.)

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IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

Officer in charge, Lieut. Col. Henry M. Robert, Corps of Engineers.

1. *Delaware River, Pennsylvania and New Jersey.*—Trenton, the head of natural navigation on the Delaware River, is about 30 miles above the upper part of the port of Philadelphia. In its original condition this part of the river was obstructed by shoals at the following localities: Between Bordentown and Trenton, a distance of about 5 miles, a narrow and circuitous channel existed, which carried from 3 to 6 feet at mean low water; at Kinkora Bar, about 9 miles below Trenton, a shoal carrying from 7 to 8 feet, and at Five Mile Bar, at the upper part of Philadelphia, a shoal carrying only 3 or 4 feet at mean low water.

Below Philadelphia the river in its original condition presented obstructions at Mifflin Bar which reduced the depth at mean low water to 17 feet, at Schooner Ledge and Cherry Island Flats to 18 feet, at Bulkhead Shoals and Dan Baker Shoal to about 20 feet.

The project for the comprehensive improvement of the Delaware River between Trenton and the upper part of Philadelphia has not yet been considered. Efforts in the past have been directed toward relieving commerce from the obstructions which exist in the upper 9 miles of the river, or that part between Kinkora Bar and Trenton. A detailed survey of the river between Bridesburg and Trenton has been made for the purpose of obtaining the necessary data for determining upon a comprehensive plan for the permanent improvement of the river between Trenton and the upper part of Philadelphia to meet the requirements of commerce, and also of the plan adopted for the improvement of the river at and below Philadelphia.

Previous to 1885 the efforts to improve the river between Philadelphia and the bay have been confined to dredging, except at Schooner Ledge, where solid rock has been removed, under appropriations for special localities, and also under general appropriations for the Delaware River below Bridesburg.

A Board of Engineers, convened by direction of the Secretary of War for the purpose of considering the subject of the permanent improvement of Delaware River and Bay, recommended, under date of January 23, 1885, the formation of a ship-channel from a point opposite Philadelphia, and about midway between the American Ship-building Company's yard and the Gas Trust Wharf to deep water in Delaware Bay, having a least width of 600 feet and a depth of 26 feet at mean low water. The formation of such a channel is to be obtained, except at Schooner Ledge, where rock would require to be removed, by regulating the tidal flow by means of dikes, with recourse to dredging where necessary as an aid to such contracting and regulating works. The estimated cost of obtaining a channel of the above dimensions is about $2,425,000, which covers the estimated cost of the permanent improvement of the Delaware River between the upper part of Philadelphia and deep water in the bay. The entire cost of the permanent improvement of the river between Trenton, N. J., and its mouth can not be stated until after the completion of the project and estimate for its improvement between Bridesburg and Trenton.

The entire amount expended on the improvement of the Delaware River from 1836 to June 30, 1887, under appropriations both for special localities and the general river was $1,613,038.27, of which $103,347.17

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was expended on that part of the river between Trenton and the upper part of Philadelphia. As a result of this expenditure there had been formed at the latter date a channel of navigable width and 7½ feet deep at mean low water through the bars between Bridesburg and Bordentown; a channel across Five Mile Bar 6½ feet deep, and past the bar, between its south side and Petty's Island, a channel 9 feet deep; a channel 450 feet wide and from 24 to 26 feet deep through the shoal areas at Port Richmond; a channel across Mifflin Bar 250 feet wide and from 22½ to 23 feet deep; a channel through Schooner Ledge 330 feet wide and 24 feet deep; a channel through Cherry Island Flats from 200 to 450 feet wide and from 24 to 26 feet deep; and a channel across Bulkhead Shoals 600 feet wide and from 20 to 21 feet deep.

The channel between Philadelphia and Camden, across Smith's Island Bar, has been improved by the formation of a dredged cut protected by revetment, so as to give a channel 150 feet wide with a minimum depth of 6½ feet at mean low water.

During the fiscal year ending June 30, 1888, the sum of $78,526.62, which includes the liabilities outstanding June 30, 1887, was expended in surveys, examinations, and tidal observations; in dike construction at Mifflin Bar and Reedy Island, and in the maintenance of a channel between Philadelphia and Camden across Smith's Island Bar, making a total expenditure since 1836 of $1,691,564.89, of which $339,564.89 has been expended on present project.

The dike at Mifflin Bar is yet incomplete, and the consequent extent of its action on the bar quite limited; a recent examination shows that the condition of the bar has practically remained unchanged during the past year. The dike at Reedy Island was commenced last year and its construction has not yet reached an extent sufficient to affect the shoal areas it was designed to improve. The channel across Smith's Island Bar has maintained a depth of from 8 to 10 feet at mean low water for a minimum width of 70 feet.

The channels at Schooner Ledge, Cherry Island Flats, and Bulkhead Shoal have remained unchanged during the year.

July 1, 1887, amount available		$94,594.64
July 1, 1887, covered by existing contracts		43,581.98
		138,176.62
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$67,741.51	
July 1, 1888, outstanding liabilities	8,195.58	
July 1, 1888, amount covered by existing contracts	36,205.04	
		112,142.13
July 1, 1888, balance available		26,034.49
Amount appropriated by act of August 11, 1888		250,000.00
Amount available for fiscal year ending June 30, 1889		276,034.49
Amount (estimated) required for completion of existing project		1,965,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix G 1.)

2. *Frankford Creek, Pennsylvania.*—This creek flows eastward to the Delaware River, through the northern portion of the city of Philadelphia. The grounds of the Frankford Arsenal border upon the left bank of the creek. In its original condition it had a low-water width of

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about 100 feet, and a low-water depth of about 5 feet at its mouth, above which it rapidly shoaled, for a distance of about 3 miles, to the head of tidal flow.

The original project proposed the formation of a dredged channel 50 feet wide from its mouth to Frankford avenue, a distance of about 3 miles, the channel to have a depth of 3 feet at mean low water at its upper end, and increasing to 7 feet at its mouth. The estimated cost was $40,000.

The act of August 2, 1882, appropriated $10,000, which was applied to the formation of a dredged channel 7 feet deep from its mouth to Horseshoe Bend.

The creek being entirely within the corporate limits of Philadelphia is being regulated by the city, and no further appropriation for its improvement by the United States is recommended.

No work has been done since 1883. The amount expended to June 30, 1888, was $9,735.50.

July 1, 1887, amount available	$264.50
July 1, 1888, balance available	264.50

Amount (estimated) required for completion of existing project	30,000.00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix G 2.)

3. *Harbor of Philadelphia, removal of Smith's Island and Windmill Island, Pennsylvania, and Petty's Island, New Jersey.*—This is a new work. In obedience to the requirements of the joint resolution of Congress, approved March 5, 1888, a Board of three engineers was appointed by the War Department "to examine and report in relation to the Delaware River between the city of Philadelphia, Pa., and Camden, N. J., and for other purposes," and its report was transmitted to Congress April 7, 1888, and printed as House Ex. Doc. No. 260, Fiftieth Congress, first session.

The plan of improvement proposed by the Board is the forming of a channel along the Philadelphia shore from Kaign's Point to Fisher's Point of ample depth, and about 2,000 feet in width, at a distance from the present wharf-line not exceeding 300 feet, to permit the extension of wharves and the widening of Delaware avenue at their shore ends, the removal of Smith's and Windmill islands and adjacent shoals, so as to give a 26-foot channel, about 1,000 feet wide, along the revised Philadelphia channel from Kaign's Point to the foot of Petty's Island. The estimated cost of the work is $3,500,000.

The river and harbor act of August 11, 1888, appropriates $500,000 for the work, of which not to exceed $300,000 is to be applied to the purchase of islands; and a further sum of $500,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$500,000.00

Amount (estimated) required for completion of existing project	3,000,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

4. *Schuylkill River, Pennsylvania.*—When the work of improvement was commenced in 1870, there was a channel of entrance into the mouth of the river carrying a depth of only 15 feet at mean low water.

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The original project under which work was commenced in 1870 proposed the formation of a channel 100 feet wide with a depth of 20 feet from the mouth of the river to Gibson's Point, and a depth of 18 feet from thence to Chestnut Street Bridge in Philadelphia.

In 1875 and 1883 this project was amended so as to increase the mean low-water channel between the mouth and Girard Point to 400 feet wide and 24 feet deep, and from Girard Point to Gibson's Point to 250 feet wide and 20 feet deep.

The amount expended upon these projects to June 30, 1887, was $368,315.13, and had resulted in the formation of a channel as follows: Between the mouth and Girard Point Piers, a distance of about 1 mile, the minimum channel was 150 feet wide and from 18 to 19 feet deep at mean low water; from Girard Point to Gibson's Point, a distance of about 3 miles, the channel was 150 to 200 feet wide and 20 feet deep; from Gibson's Point to Chestnut Street Bridge, a distance of about 3 miles, the channel was of navigable width and 18 feet deep at mean low water. This latter reach of river has required no other improvement than the removal of about 1,000 cubic yards of rock near Locust and South streets.

During the past fiscal year there have been no operations, available funds having been practically exhausted in the year ending June 30, 1887; $204 was expended for office expenses.

In the opinion of the officer in charge the shoal areas between the mouth and Girard Point can be more economically improved by the construction of a dike than by the hitherto proposed dredging.

July 1, 1887, amount available	$434.87
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	204.00
July 1, 1888, balance available	230.87
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,230.87
Amount (estimated) required for completion of existing project	91,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 3.)

5. *Ice-harbor at Marcus Hook, Pennsylvania.*—This work in its present plan was commenced in 1867, the object being to provide a harbor to protect vessels against moving ice.

The original project, with the amendments thereto, proposed the construction of stone piers behind which vessels could anchor, and the construction of a bulkhead, about 1,800 feet in length, parallel to the shore-line, and about 150 feet outside of high-water line, together with the deepening by dredging of the area behind the piers and in front of the bulkhead.

The amount expended from 1866 to June 30, 1887, was $179,791.86, and resulted in the construction of two shore-piers and seven detached ice-piers; the deepening by dredging to a depth of from 18 to 24 feet of the area behind the two upper pairs of ice-piers, and the placing of nine groups of mooring piles, seven of which were placed at low-water line and two behind the ice-piers. Extensive repairs have been made to the shore and landing piers from time to time.

The work done had rendered available about 6 acres of harbor area with a depth of from 8 to 24 feet, and about 2 acres with a depth of from 12 to 18 feet at mean low water.

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During the fiscal year ending June 30, 1888, $14,127.43 was expended in removing Pier No. 6 from its previous site on a pile foundation and rebuilding it upon a crib foundation at a point 100 feet inshore from the lower ice-pier. Two groups of mooring piles were placed between existing piers, and 58,000 cubic yards of material dredged from the previous shoal areas at the lower part of the harbor. This dredging has increased the area of that part which is under the protection of the piers from 6 acres to 10 acres. The depth at low water which covers this area is from 18 to 24 feet. The total expenditure to June 30, 1888, has been $193,919.29.

The two landing or shore piers, over twenty years old and made of timber, and also several of the ice-piers, are in need of repairs, and the efficiency of the harbor would be increased by additional dredging.

The officer in charge recommends the abandonment, for reasons given in his report, of that part of the present project which provides for the construction of a bulkhead along the land-face of the harbor, and suggests that, at least for the present, available funds be applied to the full development of the present harbor by repairs to the piers and dredging.

July 1, 1887, amount available	$6,586.54
July 1, 1887, amount covered by existing contracts	7,621.60
	14,208.14
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14,127.43
July 1, 1888, balance available	80.71
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,080.71
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 4.)

6. *Ice-harbor at head of Delaware Bay, Delaware.*—The act of August 2, 1882, appropriated $25,000 for the commencement of work on the ice-harbor at the head of Delaware Bay, to include the removal of some sunken piers, the remains of an old ice-harbor, in the channel east of Reedy Island, Delaware.

The necessity for an ice-harbor at the head of Delaware Bay has long been recognized, and considerable study has been devoted to the questions of location and general plan of construction. As to location, the prevailing judgment would place the ice-harbor at or very near Liston's Point. The plan of construction which has been hitherto proposed in general terms provided for a nearly inclosed area by means of a barrier, to protect vessels against moving ice. This barrier was to consist of iron piles placed at intervals and connected with an iron superstructure so arranged as to either hold or ward the ice from the area within the barrier. The cost of such an ice-harbor has been variously estimated at from $300,000 to $400,000.

In the opinion of the officer in charge, the plan of detached ice-breakers, as heretofore used in all the ice harbors on the Delaware River, is preferable to that of an inclosed area, which latter would prevent the broken ice from escaping from the harbor; but as to whether these ice-breakers should consist of stone piers, or pile piers, or floating pontons, requires more time for decision.

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The amount expended to June 30, 1887, was $8,723.07, of which $3,700 was applied to the removal of the sunken piers back of Reedy Island, as provided in the act of August 2, 1882, making the appropriation of $25,000. The balance was expended in surveys, examinations, and preliminary studies.

During the fiscal year ending June 30, 1888, $1,216.37 was expended for office expenses.

No appropriation is recommended at present by the officer in charge.

July 1, 1887, amount available	$17,493.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,216.37
July 1, 1888, balance available	16,276.93

(See Appendix G 5.)

7. *Construction of iron pier in Delaware Bay, near Lewes, Delaware.*—The original project for this work proposed the construction of a landing-pier about 1,700 feet in length, extending from the shore south of the breakwater into Delaware Bay to a depth of 22 feet at mean low water, the pier to consist of a substructure of wrought-iron screw-piles surmounted with a timber superstructure. The work was commenced in 1871 and completed, except as to superstructure, in 1880.

The amount expended to June 30, 1887, was $368,375.06, and resulted in the construction of 1,155 linear feet of pier 21 feet in width, and 546 linear feet 42 feet in width, or a total length of 1,701 feet. The depth of water at the outer end of the pier-head was about 21 feet at mean low water.

During the fiscal year ending June 30, 1888, nothing was expended.

During the gale of March 12, 1888, five of the wrought-iron screw-piles were injured by the collision of a wrecked schooner. The injury to the pier was limited to its half width for a distance of about 125 feet. The officer in charge estimates that the cost of repairing this injury will probably reach $6,000.

From the decayed condition of the timber supestruction it is not available for use by the railroad to which the right was given to use the pier under the provisions of the act of July 15, 1870.

If the pier is to be rendered available for the general purposes of the Government, and also for railroad traffic, as contemplated in the act above referred to, the officer in charge recommends the replacing of the present decayed wooden superstructure by permanent iron-work at an estimated cost of $93,000.

July 1, 1887, amount available,	$124.94
July 1, 1888, balance available,	124.94
Amount (estimated) required for completion of existing project, Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$15,000.00

(See Appendix G 6.)

8. *Delaware Breakwater Harbor, Delaware.*—Under act of Congress, May 7, 1822, $22,700 was appropriated for a survey of Delaware Bay, near Cape Henlopen, for the purpose of determining upon the site for a harbor of shelter. In 1828 an appropriation of $250,000 was made for commencing the work under a plan submitted by a Board of Commissioners appointed by Congress.

The project of the Board contemplated the construction in the concavity of the bay, just inside Cape Henlopen, of two massive works on the

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pierres perdues or riprap system, separated by an interval or gap of 1,390 feet—the greater, called the breakwater, to afford safe anchorage during gales from the north and east; the other, called the ice-breaker, to protect shipping against northwesterly gales and the heavy drifting ice of the bay.

This project was completed in 1869, under aggregate appropriations, including the first for survey of $2,192,103.70. The stone used in the work amounted to 892,528 gross tons, and varied from one-quarter of a ton to 7 tons in weight, the smaller constituting the bulk of the mass, the larger used to cover the exterior slopes.

As completed in 1869 the breakwater is 2,558 feet long, and the ice-breaker 1,359 feet long on top. The average width on top is 22 feet, and at base 160 feet. The top is from 12 to 14 feet above mean low water.

In 1882 a project was adopted for closing the gap between the breakwater and the ice-breaker by means of a random stone foundation with a concrete superstructure. The random stone foundation is to be brought to a height of 12 feet below low water, with a width on top of 48 feet. The concrete superstructure is to have a width on bottom of 24 feet, rising to a height of 12 feet above mean low water, with a width on top of 12 feet. The estimated cost of this project was $675,000.

In 1883 and 1884 the project was modified by providing a foundation of brush mattresses for the random stone substructure, and omitting the construction of a pile bridge across the gap, which formed part of the project of 1882 for closing the gap.

From the beginning of the work in 1822 to June 30, 1887, the total amount expended was $2,445,667.73, of which $253,564.03 was expended on the project of 1882 for closing the gap.

The officer in charge calls attention to the fact that the completion of the work will probably cost more than the $418,750 estimated in the money statement. A revision of the estimate should be postponed until the completion of the foundation which is in progress.

During the fiscal year ending June 30, 1888, $2,155.88 was expended for office expenses and care of public property. The total expenditure to June 30, 1888, has been $2,447,823.61, of which $255,719.91 has been under present project.

July 1, 1887, amount available	$2,685.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,155.88
July 1, 1888, balance available	530.09
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	100,530.09

Amount (estimated) required for completion of existing project	318,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 7.)

9. *Rancocas River, New Jersey.*—The Rancocas is a comparatively large and important stream, 200 yards wide at its mouth, and narrows to about 400 feet at a distance of 8 miles above. As is usual with rivers entering into the Delaware Bay and River, a bar exists at its mouth, difficult to treat effectively and cheaply on account of the liability of the cuts to close up unless protected by deflecting dikes. There is, how-

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ever, a low-water navigable depth of nearly 8 feet over this bar at present.

The original project provided for a low-water channel from 150 to 200 feet wide and 6 feet deep at low water to Centreton, 7¼ miles above the mouth, and eventually a 5-foot low-water channel to Mount Holly, 5¾ miles above Centreton. The estimated cost of the whole was $82,000. The amount expended up to June 30, 1887, was $19,899.91, resulting in the construction of a dike from the head of Hamill's Island to the north bank of the river, and a 6½-foot low-water channel 150 feet wide cut through Coates's Bar.

Nothing was expended during the last fiscal year.

Nothing has been appropriated by last river and harbor act.

July 1, 1887, amount available	$100.09
July 1, 1888, balance available	100.09
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	62,000.00

(See Appendix G 8.)

10. *Woodbury Creek, New Jersey.*—The lower part of Woodbury Creek, from its mouth to the Crown Point Road Bridge, is considered to have sufficient depth of water at high stages of the tide for the needs of navigation. The portion which should be improved is the reach extending from this bridge to the Broad Street Bridge, in the town of Woodbury, at the head of navigation. At low tide this portion of the creek is almost entirely devoid of water, but the range of tide being between 5 and 6 feet, small vessels can ascend at high stages.

The project of 1883 proposed to dredge a channel affording a high-water depth of 8 feet and a width of 40 feet from Crown Point Road Bridge to Broad Street Bridge in the town of Woodbury, at an estimated cost of $15,000. This channel when once made is to be maintained by the parties interested.

The partial dredging of a channel being of no commercial value, expenditures have been withheld to await further appropriation sufficient to complete the dredging as far as Woodbury.

July 1, 1887, amount available	$4,549.69
July 1, 1888, balance available	4,549.69
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,500.00

(See Appendix G 9.)

11. *Mantua Creek, New Jersey.*—The original project for this improvement contemplates the construction of a low-water channel 10 feet deep and 80 feet wide at the mouth of the creek, which is to diminish to 4 feet in depth and 40 feet in width at the town of Mantua, situated some 11 miles from the mouth, at an estimated cost of $35,000.

The stream in its natural condition possesses good depth of water for a distance of 3 or 4 miles from the Delaware River, having a low-water depth of 9 feet throughout this distance. Above this, however, the channel depth slowly diminishes, until at Mantua there is a low-water depth of only 2 feet.

No money has yet been expended on the work, and since whatever dredging done here would not be permanent, no further appropriation is recommended.

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July 1, 1887, amount available	$3,000.00
July 1, 1888, balance available	3,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	32,000.00

See Appendix G 10.)

12. *Raccoon River, New Jersey.*—This river has a high-water width at its mouth of about 450 feet, gradually diminishing to 100 feet at Swedesborough, about 9½ miles up-stream. There is a good 4-foot low-water channel, and a high-water channel of from 9 to 10 feet from the mouth of the river to more than half the distance to Swedesborough. The serious and extensive obstructions are found within 2 miles of that town. There are four bridges across the stream. Two of these are located at Bridgeport, about 2 miles above the mouth of the river, and the other two at Swedesborough. The lower one of the two latter is the Swedesborough Railroad Bridge, and barges can pass under it. The upper one is the Main Street Bridge, and is the head of navigation.

The project submitted with the report on the survey, dated February 26, 1883, contemplates making the navigation up to Main Street Bridge in Swedesborough more safe and less difficult for the class of vessels now navigating the stream by dredging, at an estimated cost of $18,000.

The sum of $757.23 was expended up to June 30, 1883, for surveys, and nothing since, the balance on hand being held to await further appropriation.

July 1, 1887, amount available	$2,242.77
July 1, 1888, balance available	2,242.77
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,000.00

(See Appendix G 11.)

13. *Salem River, New Jersey.*—The original navigable capacity of this stream was 6 feet at low water over the bar in Salem Cove, and 3 to 4 feet at low water on the shoals at Biddle's Landing.

The originally adopted project consisted in dredging an 8-foot low-water channel as wide as the vessels needed, through the bar in Salem Cove. Subsequently the work was changed to the shoals in the canal and river above the latter.

The amount expended to June 30, 1887, was $13,009.34, resulting in a low-water channel 8 feet deep and 110 feet wide through the bar in Salem Cove, and a channel 60 feet wide and from 6 to 7 feet deep at low water from the head of the canal to a point about 200 feet above Biddle's Landing.

Nothing was expended during the fiscal year ending June 30, 1888.

The estimated amount required to complete the work according to the existing project, that is, to Hoxie's Landing, is $4,000. If the improvement is carried up to Sharptown the amount would be $37,000.

July 1, 1887, amount available	$1,490.66
July 1, 1888, balance available	1,490.66
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

(See Appendix G 12.)

14. *Cohansey Creek, New Jersey.*—Cohansey Creek, in its original condition, was navigable to Bridgeton, 20 miles above its mouth, through

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a tortuous channel of ample depth. The obstructions to its free navigation were found at Bridgeton and at its mouth, where the creek discharged across a soft mud-bar without any well-defined channel. The gas and water mains of the city of Bridgeton cross the creek at Broad street, at a level of only 4 feet below low water, and prevent the further deepening of the channel above them. In the event of the city authorities lowering the pipes to a proper depth, the amount required to complete the project by carrying a 6-foot low-water channel to the Nail Works Bridge would be about $5,500.

The original project contemplated the construction of a channel at Bridgeton 130 feet wide and 4 feet deep, at a total cost of $30,000. This was modified to reduce the width to 80 feet, and to increase the depth at mean low water to 7 feet from the lower steam-boat landing to the bridge, and above that point to 5 feet. This project, as again amended in June, 1880, contemplates bringing the 7-foot low-water channel from deep water below the lower steam-boat landing upward as far as the Commerce Street Bridge, and thence to the Nail Works Bridge a low-water channel of 6 feet, the channel to be 100 feet wide at its lower end and to decrease to 50 feet at the upper bridge.

The total amount expended to June 30, 1887, was $36,000. The 7-foot low-water channel has been widened and straightened, and it is now 90 feet wide between the upper and lower steam-boat wharves, and 70 feet above that to the bridge.

Amount (estimated) required for completion of existing project	$5,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G 13.)

15. *Removal of wrecks from Delaware Bay and River.*—During the past fiscal year the obstructing parts of the wreck of the schooner *David Lee*, lying near Fourteen Foot Bank Light, Delaware Bay, were removed.

July 1, 1887, amount available	$2,290.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,531.98
July 1, 1888, balance available	758.62

(See Appendix G 14.)

16. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the past fiscal year the following wrecks were removed under the provisions of the act of June 14, 1880: The schooner *G. H. Bent*, from Delaware Breakwater Harbor, and the steamer *Blanche Henderson*, from the port of Philadelphia. After being raised the latter was sold at public auction for the sum of $570.

(See Appendix G 15.)

17. *Survey of harbor at Atlantic City, New Jersey.*—The report of the Board of Engineers upon this subject was submitted under date of May 31, 1887, and is to be found in the Report of the Chief of Engineers for 1887, pages 815–819.

During the past fiscal year the maps and data of the survey and report were assembled and placed on the office files.

July 1, 1887, amount available	$2,798.32
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,217.93
July 1, 1888, balance available	1,580.39

(See Appendix G 16.)

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18. *United States Commission Advisory to the Board of Harbor Commissioners of Philadelphia, Pennsylvania.*—The United States Commission Advisory to the Board of Harbor Commissioners of Philadelphia have had under consideration the establishment of the Port-Wardens' lines. During the past fiscal year the Port-Wardens' line from Bridesburg to the upper limits of the city on the Delaware River front were fixed by the Commission and adopted by the municipal authorities.

The Commission was requested to report upon the problem of the removal of Smith's and Windmill Islands and adjacent shoals for the purpose of extending the wharves on the Pennsylvania side of the river. Their report on this subject, submitted under date of December 15, 1887, expresses the belief that it would be feasible to advance the Port-Wardens' line 300 feet in the center of the city front on the Delaware River, provided certain modifications were made in the harbor, including the removal of Smith's and Windmill Islands and the shoals adjacent thereto and a portion of Petty's Island.

(See Appendix G 17.)

EXAMINATIONS AND SURVEY FOR IMPROVEMENTS, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination, that the locality was worthy of improvement, Lieutenant-Colonel Robert, Corps of Engineers, was charged with the survey of the *thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J.*, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 306, Fiftieth Congress, first session.

(See Appendix G 18.)

IMPROVEMENT OF HARBORS AND RIVERS IN THE STATES OF DELAWARE AND MARYLAND, AND OF MAURICE RIVER, NEW JERSEY, AND OF THE INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY.

Engineer in charge, Mr. William F. Smith, United States Agent.

1. *Maurice River, New Jersey.*—The entrance of this river into the Delaware Bay has a low-water depth of 5 feet. From its mouth to a point 4 miles below Millville, N. J., the head of navigation, there is a navigable channel varying in depth from 10 feet to 20 feet, and from thence to Millville the channel originally had an average depth of 2½ feet at low water. The tide rises 6.1 feet.

The original project adopted for this improvement is to construct, by dredging, a 6-foot low-water navigation from the mouth of the river to Millville, and a 4-foot low-water navigation along the front of the town; the width of channel to be 100 feet.

The estimated cost was $112,000. The amount expended to the close of the fiscal year ending June 30, 1887, is $20,032.74, and at that date a channel had been dredged to a depth varying from 5 to 6 feet at low water, from 50 to 100 feet in width, including a cut-off through the point of land at Silver Run, through which the right of way was given to the United States free of cost. This cut-off shortened the distance in the 4 miles of river under improvement 1,300 feet.

The work was advertised for continuing the improvement, under the appropriation of August 5, 1886. The amount expended during the

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fiscal year ending June 30, 1888, is $4,952.42, resulting in increasing the width of the channel from 50 feet to 100 feet at bottom, a distance of 3,050 feet, giving a depth of 6 feet at low water. The 100-foot channel has been extended to within 5,350 feet of the head of navigation.

July 1, 1887, amount available	$4,967.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,952.42
July 1, 1888, balance available	14.84
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,014.84
Amount (estimated) required for completion of existing project	77,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 1.)

2. *Wilmington Harbor, Delaware.*—The entrance of this harbor from the Delaware River had originally but 9 feet low-water draught. The original project for this improvement was for the attainment of a 12-foot low-water navigation at the entrance; this work continued from 1871 to 1880.

In 1880 a modified project was adopted, the object of which is to give a 15-foot low-water navigation from the entrance to the Delaware Railroad Bridge. In 1884 the project was again amended, which provided for an additional length of 322 feet to the jetty. The condition of the harbor in 1880 was as follows:

From the entrance and to the city of Wilmington, Del., a 12-foot low-water navigation existed. Between Third and Market Street bridges, 4,000 feet, covering the main city front, the 12-foot navigation continued with a reduced width averaging about 50 feet, and a 15-foot low-water depth existed about one-fourth of the distance. Between Market Street and the Delaware Western Railroad Bridge the channel increases in both dimensions, with numerous soundings over 20 feet and an average width of 100 feet. The depth thence to the Pulp Works was from 9 to 11 feet, and thence to the Delaware Railroad Bridge the depth remains about the same, with the exception of a distance of 2,000 feet below Dupont's powder wharf, over which the average low water is 4 to 5 feet. During the present fiscal year the dredging was continued from a point 6,200 feet inside the mouth of the harbor to the end of the jetty, excavating the channel 75 feet wide and 15 feet deep at mean low water. This was completed in July, and work was suspended for want of funds.

The total amount expended to close of the fiscal year ending June 30, 1888, is $255,028.57, and has resulted in securing a channel 75 feet in width and 15 feet in depth at mean low water (except at two places where the material is very soft and the channel has filled to 10 feet) from the entrance of the harbor to Market street, and excavating a channel from Market Street Bridge to the Pulp Works, a 12-foot low-water navigation. No work having been done and no examination made above Market Street Bridge during the year, the condition of the 12-foot channel dredged there is unknown. The amount available and that asked for the fiscal year ending June 30, 1890, if appropriated, will be applied to continuing the improvement in accordance with the pro-

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ject adopted. The amount estimated to maintain the improvement is from $5,000 to $10,000 annually.

July 1, 1887, amount available	$8,199.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,033.05
July 1, 1888, balance available	2,166.21
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	32,166.21
Amount (estimated) required for completion of existing project	117,634.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

(See Appendix H 2.)

3. *Ice-harbor at New Castle, Delaware.*—The original project for this improvement was to build stone piers in the Delaware River at New Castle, Del., to provide a harbor of refuge for vessels during the ice season.

The piers, eight in number, have been completed, and the area of the harbor dredged to a depth of 18 feet at mean low water.

During the fiscal year the work done consisted in repair of damages to one of the piers caused by collision from a vessel, and placing riprap around the bottom of two piers to prevent scouring. Amount expended during the current fiscal year is $853.20. One of the piers is in a most insecure condition and requires rebuilding, and the dredging should also be extended beyond the piers to produce a current through the harbor to prevent filling, and the amount asked for the fiscal year June 30, 1890, if appropriated, will be applied to this object. The total amount asked for should be available before the work of rebuilding the pier has commenced.

July 1, 1887, amount available	$853.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	853.20
Amount appropriated by act of August 11, 1888	7,500.00
Amount (estimated) required for completion of existing project	8,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,100.00

(See Appendix H 3.)

4. *Duck Creek, Delaware.*—In its original condition this stream was obstructed by a bar at its entrance, having 3 feet draught at low water, and between the mouth and Smyrna, the head of navigation, there existed nine shoals with a minimum depth of 2.5 feet.

The original adopted project was to excavate a channel through the bar at the mouth 8 feet in depth at mean low water, and 100 feet in width, and to remove the shoals by dredging to the same depth as far as Smyrna.

In compliance with the act of August 5, 1886, a survey was made of this stream, and a modified project with estimate of cost of improvement was submitted (see Annual Report of Chief of Engineers for 1887, page 800). It is deemed at present that a channel 60 feet wide and 7 feet deep at mean low water inside the creek, and at the entrance a channel 100 feet wide and 7 feet in depth at mean low water, is sufficient for the needs of commerce.

The estimated cost of the dredging is $37,365.20. It is barely possi-

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ble that annual dredging to the amount of 10,000 cubic yards may keep a practicable channel over the bar 100 feet wide.

A more permanent improvement would require the construction of a jetty 2,000 feet in length, which would cost, of wood, $20,000; of stone, $53,333.20.

In 1880 and 1881 $10,000 was expended in dredging a channel through the bar at the entrance to 8 feet in depth at mean low water, but the survey of 1887 shows the work had filled to 4½ feet.

The citizens have spent $6,500 in dredging inside the creek.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	27,365.20
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix H 4.)

5. *St. Jones River, Delaware.*—Before the improvement of this river was commenced the entrance from the Delaware River had only 2 feet of water on it at mean low tide.

From the mouth to Lebanon there existed only a 4-foot low-water navigation, and from thence to Dover 2.5 feet at low water.

Many bends also interfered with navigation, and between Lebanon and Dover navigation was obstructed by overhanging trees.

The original project adopted for the improvement provided for a 6-foot low-water navigation by excavating a channel through the bar at the entrance 100 feet wide, to be protected by a jetty; to remove the shoals and make several cut-offs, by dredging, between the mouth of the river and Dover, and in 1887 the project was amended to include removal of overhanging trees from the banks of the river. During the fiscal year ending June 30, 1888, a channel 40 feet wide and 6 feet deep at mean low water was completed from a point about one fourth of a mile below Dover to that place and a turning-basin excavated; through the bar at the entrance to the river a channel 40 feet wide and 4 feet deep at low water was excavated a length of 1,050 feet. The appropriation being about exhausted, the citizens interested in the navigation employed the dredging company to extend this channel 1,350 feet further, for which they paid from their private funds. The banks were also cleared of overhanging trees between Lebanon and Dover. To the close of the fiscal year ending June 30, 1888, $24,999.64 have been expended in all on this improvement, and has resulted in giving a 4-foot low-water navigation over the entrance to the river and a 6-foot low-water navigation thence to Dover, the head of navigation, distance about 21 miles. A steamer makes regular trips between Dover and Philadelphia, and the railroad freight rates have been considerably reduced.

July 1, 1887, amount available	$2,245.86
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,245.50
July 1, 1888, balance available	.36
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,000.36
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix H 5.)

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6. *Mispillion Creek, Delaware.*—This stream has a width of about 90 feet at Milford, the head of navigation, increasing to 240 feet at its mouth. The entrance from Delaware Bay had a depth of 1½ feet at mean low water, and between the mouth and Milford were several shoals having a depth from 4 to 5 feet over them.

The original project was to make a 6-foot low-water navigation with a width of 40 feet from the mouth to the head of navigation. This project was amended in 1881 to include the improvement of the entrance from Delaware Bay, providing a 4-foot low-water navigable entrance. The tide rises 4½ feet at the entrance and 2½ feet at Milford.

The amount expended to the close of the fiscal year ending June 30, 1888, is $13,500. This amount was applied to dredging the shoals between the mouth of the river and Milford to a depth of 6 feet at mean low water, and the work done was of much benefit to the ship-building and commercial interests of the locality.

Nothing has been done since 1883 for want of funds, and the condition of the stream at present is unknown for the same reason.

Amount appropriated by act of August 11, 1888	$3,500.00
Amount (estimated) required for completion of existing project	55,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 6.)

7. *Broadkiln River, Delaware.*—Before any improvement was made in this river the channel was narrow, shallow, and tortuous, and nearly dry at its entrance into Delaware Bay at low water, and navigable for only small crafts. The original project adopted for the improvement proposed giving a 6-foot low-water navigation from Delaware Bay to Milton, the head of navigation.

The amount expended to the close of the fiscal year ending June, 30, 1887, is $25,000, which resulted in giving a channel 6 feet in depth at mean low water, and in no place less than 40 feet in width from the mouth of the river to Milton.

The benefit due to the improvement is the saving in time of two to three days in passing from the mouth to Milton. There were no operations during the fiscal year ending June 30, 1888, for want of funds, and for the same reason the condition of the river at that date is unknown.

The total amount that has been appropriated for this river is $25,000. The amount asked for the fiscal year ending June 30, 1890, if appropriated, will be applied to the improvement of the entrance with a view to attaining a 6-foot low-water navigation.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	21,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 7.)

8. *Indian River, Delaware.*—This river originally was available for only 2 feet navigation at mean low water. The original project for the improvement contemplates dredging a channel 80 feet wide and 4 feet deep through "The Bulkhead," thence straight to the inlet, and protecting it by the construction of a dike on its northern side. The cost was estimated at $50,000.

The amount expended up to the close of the fiscal year ending June 30, 1888, is $10,000. A channel was dredged through the Bulkhead

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Shoal 4 feet in depth, with a width of 80 feet for two-thirds of the length, and 60 feet in width for the other one-third. It is reported that the channel filled up soon after it was made, and no benefit was derived from the improvement.

No work has been done on this improvement since 1883 for want of funds.

The dredging will cost more than the original estimate, and should the work be continued the appropriation should be sufficient to construct the protecting work as well as to excavate the channel, to derive any benefit from the improvement.

Amount (estimated) required for completion of existing project	$50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 8.)

9. *Inland water-way from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware.*—The project adopted for this improvement is to connect, by dredging, the natural waters between Chincoteague Bay, Virginia, and Delaware Bay, Delaware, forming a continuous water-way 70 feet wide at bottom and 6 feet in depth at mean low water.

The route was surveyed in 1884, and the report is contained in the Annual Report of the Chief of Engineers, 1885.

The act of August 5, 1886, appropriated $18,750 for the commencement of the improvement, and directed the sum "to be used from Chincoteague Bay to Indian River Bay."

The Delaware legislature passed an act in 1887 providing for the purchase of the right of way and donating the same to the United States. The work will be commenced as soon as the title to the lands needed for the right of way has been approved at the Department of Justice.

The total amount expended to the close of the fiscal year ending June 30, 1888, is $821.41, which was applied to surveys to locate the route between Assawamom Bay and Indian River Bay.

July 1, 1887, amount available	$17,946.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17.98
July 1, 1888, balance available	17,928.59
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	67,928.59

Amount (estimated) required for completion of existing project	281,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

See Appendix H 9.)

10. *Susquehanna River above and below Havre de Grace, Maryland.*—Before the improvement of this river it was obstructed by two shoals between the light-house at Havre de Grace and Spesutia Island, over which the depths were only 5 feet and 6 feet at mean low water; and above Havre de Grace, near Watson's Island, the channel was too narrow for the ice to pass off, which caused dangerous ice gorges.

The original project adopted for the improvement was for a 12-foot low-water navigation, and in 1882 it was amended, the object being to afford a 15-foot low-water navigation below Havre de Grace. Above Havre de Grace the project has been to increase the width and depth of the channel near Watson's Island, to prevent ice-gorges.

The amount expended to the close of the fiscal year ending June 30,

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1887, is $148,890, and at that date the channel above Havre de Grace, near Watson's Island, had been increased 400 feet in width at the upper end of the shoal, and 300 feet at the lower end of the shoal.

There has been no work done on the shoals below Havre de Grace since 1885, as Congress directed the last appropriations to be all spent above, and the condition of the channel is not known at this date.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for annual dredging	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 10.)

11. *Fairlee Creek or Inlet, Maryland.*—This is a new work. An examination and survey was made in compliance with the requirements of the river and harbor act of August 5, 1886, and printed as Appendix H of the Report of the Chief of Engineers for 1887.

The improvement proposed is the removal of the bar by dredging to 7 feet, which is the least efficient depth, at an estimated cost of $3,545.75, and the dredging of a channel 7 feet deep and 100 feet wide from the mouth to the turning basin, at an estimated cost, including contingencies, of about $12,000, making an aggregate of $15,558.

The river and harbor act of August 11, 1888, appropriates for the improvement $5,000, and a further sum of $11,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	10,558.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

12. *Corsica Creek, Maryland.*—Before the improvement of this stream it was navigable for steamers only as far as Hooper's Landing; from thence to Centreville freight was transported by lighters.

The originally adopted project for this improvement proposed to construct, by dredging, a channel 100 feet wide and 8 feet deep at mean low water from Hooper's Landing to the town of Centreville, and to excavate a turning basin at the terminus.

The total amount expended to the close of the present fiscal year is $20,000, and has resulted in giving a channel 100 feet wide at bottom and 8½ feet in depth at low water from a point 2,300 feet above Hooper's Landing to Clark's Wharf; a cut of 60 feet was taken off the point opposite the wharf; from thence to the county bridge, 1,000 feet, a channel was excavated 75 feet wide and 8½ feet deep at low water, and the turning basin dredged there. The channel excavated has been in constant use, and the facilities for commerce and navigation greatly increased and the freight rates reduced.

There were no operations during the current year for want of funds.

The amount available will be applied to dredging the channel 100 feet wide at bottom and 8 feet deep at low water from Hooper's Landing to a point 2,300 feet above, which will complete the project.

July 1, 1887, amount available	$19.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19.49
Amount appropriated by act of August 11, 1888	10,000.00

(See Appendix H 12.)

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13. *Choptank River, Maryland.*—Before the improvement of this river, the navigable channel, except at one point, as high up as Denton, had a depth of 9 to 10 feet at low water. Between Denton and Greensborough the width varied from 100 feet to 650 feet, and the depth from 2 feet to 8 feet at mean low water.

The original project for the improvement was to give an 8-foot low-water navigation 75 feet in width between Denton and Greensborough, Md., by dredging through the numerous shoals. During the fiscal year ending June 30, 1888, a channel was excavated 25 feet wide and 8.5 feet deep at low water a distance of 2,738 feet, and 40 feet wide and 7 feet deep at low water a length of 7,036 feet; also a turning-basin at Greensborough 125 feet long and 100 feet wide in addition to the channel width. The total amount of material removed is 45,220 cubic yards. The total amount expended to the close of the present fiscal year is $30,000, and has resulted in securing a channel from 5 feet to 8 feet in depth and from 25 feet to 75 feet in width, between Denton and Greensborough, Md.

The dredging has been at shoals with less depth than 5 feet. Future appropriations will be applied to increasing the 5-foot shoals to 8 feet at low water and the width to 75 feet, as recommended in the project.

July 1, 1887, amount available	$8,849.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,849.97
Amount appropriated by act of August 11, 1888	7,500.00
Amount (estimated) required for completion of existing project	39,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 13.)

14. *Cambridge Harbor, Maryland.*—An examination and survey of this harbor were made under the requirements of the river and harbor act of August 5, 1886, and the report made is printed in Appendix H of the Report of the Chief of Engineers for 1887.

A survey of the harbor was made in 1870 and its improvement was commenced in 1873, when the commerce was carried by one 300-ton steamer and one sailing vessel. Since 1871 the United States has expended $32,500 in dredging the harbor and entrance to a depth of 8.5 feet at mean low water, to the great benefit of commerce.

The improvement proposed by the officer in charge of the survey contemplates dredging a channel 12 feet deep and 150 feet wide from the Choptank River to the railroad wharf, and in the inner harbor 10 feet deep. The inner harbor above the bridge to be dredged 150 feet wide, 500 feet long, and 8 feet deep, at an estimated cost of $17,736.60. It is also estimated that $500 to $1,000 will be required annually to maintain the channel.

The river and harbor act of August 11, 1888, appropriates $5,000 for this harbor, and a further sum of $13,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	12,736.60
Amount that can be profitably expended in fiscal year ending June 30, 1890	13,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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15. *Nanticoke River, Delaware.*—By act of August 5, 1886, $10,000 was appropriated for "continuing the improvement up to and near the town of Laurel, Delaware." Before any improvement was made the depth of water between Pottsville and Laurel, a distance of 4 miles, varied from 3 feet to one-half foot, and vessels could not reach Laurel. In 1882 a channel was excavated 32 feet wide and 6 feet deep at mean low water, from the railroad bridge at Laurel to a point 6,900 feet down-stream, and for a further distance of 4,300 feet the natural channel straightens by cutting off some sharp bends. In 1886 a survey was made of the river, and a continuous 5-foot low-water navigation was found to extend to a point 7,000 feet below the turning-basin at Laurel, and a 4-foot low-water navigation 2,900 feet below the same place. The project adopted for the expenditure of the available funds was to extend the 5-foot low-water navigation to the turning-basin, the channel to be 45 feet in width, and to cut off several sharp bends in the lower part of the river. The price for which the dredging was contracted being much less than was estimated, more work was done than originally proposed.

The total amount expended to the close of the present fiscal year is $10,000, and the following is the result, viz: Commencing at the turning-basin and working down-stream, a channel 45 feet wide and 5 feet in depth at low water was excavated to the Delaware Railroad Bridge, a distance of 1,950 feet. From the Delaware Railroad Bridge to the intersection of the 7-foot curve, a distance of 12,350 feet, a channel 50 feet wide and 6 feet in depth at low water was excavated; and at three bends the width increased to 60, 70, and 60 feet, respectively. Also, at Collin's Bar, about one-half mile further down-stream, a cut was excavated 600 feet in length, 50 feet in width, and 6 feet deep at low water.

The citizens of Laurel expended between $12,000 and $13,000 in building wharves and dredging in front of them.

July 1, 1887, amount available	$8,939.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,939.09

For balance of statement see money statement for Broad Creek, Delaware.

(See Appendix H 14.)

16. *Broad Creek, Delaware, from its mouth to Laurel.*—This is a prong of Nanticoke River. The original project was to make a channel 7 feet in depth and 60 feet wide to the town of Laurel, the estimated cost of which was $46,500; if training-walls to regulate the water-way are constructed, the estimate should be increased to $60,000. This project was modified in 1883, and the dimensions of the channel recommended were reduced to 6 feet in depth at mean low water and 50 feet in width, and the building of dikes for the protection of the channel. The estimated cost of the latter project is $32,625. The amount expended up to the close of the fiscal year ending June 30, 1888, is $20,000, and a channel was excavated 32 feet wide and 6 feet deep at mean low water, from the railroad bridge at Laurel to a point about 6,900 feet down-stream, and the natural channel below this point straightened and widened by cutting off some sharp points for a further distance of 4,300 feet.

There has been no appropriation for Broad Creek since 1882.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	27,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H 15.)

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17. *Pocomoke River, Maryland.*—This river was obstructed by four abrupt bends, which render navigation both difficult and dangerous at all times, and when the winds were high they were almost impassable.

The original project adopted for the improvement is to make a cut-off through the low neck of land or swamp forming the bends, giving a channel 80 feet wide and 7 feet deep at mean low water; the cut-off to be 1,100 feet in length; the right of way for the cut-off to be conveyed to the United States free of cost.

The title to the land for the right of way having been approved and the land accepted by the Secretary of War, the work was advertised and a contract made with the Atlas Dredging Company for 10 cents per cubic yard, place measurement. The price being less than the original estimate, it was recommended and approved to apply the balance of the funds to removal of several shoals to a depth of 7 feet at low water below the cut-off, and dredging a turning-basin at Snow Hill.

The amount expended during the present fiscal year is $6,777.51, including outstanding liabilities, and the improvement as recommended in the above project has been completed.

At this date there is a good 7-foot low-water navigation to Snow Hill, Md., the head of navigation.

July 1, 1887, amount available		$8,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,132.41	
July 1, 1888, outstanding liabilities	2,645.10	
		6,777.51
July 1, 1888, balance available		1,222.49

(See Appendix H 18.)

18. *Removing sunken vessels or craft obstructing or endangering navigation.*—At the close of the last fiscal year a contract had been made with Mr. Edward T. Veasey, of Lewes, Del., under provision of section 4 of the act of June 14, 1880, for the removal of the wreck of the steam-propeller *J. I. Van Doren* from the Broadkiln River, Delaware. The work was begun promptly and completed by the 20th of July, 1887, at a total cost of $242.13. The wreck was of no value.

(See Appendix H 19.)

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND; OF THE HARBOR OF NORFOLK, VIRGINIA; APPROACH TO NORFOLK HARBOR, VIRGINIA; OF CURRITUCK SOUND, AND CO-ANJOK BAY, AND OF NORTH RIVER BAR, NORTH CAROLINA; OF JAMES AND APPOMATTOX RIVERS, VIRGINIA; AND OF CERTAIN OTHER RIVERS IN VIRGINIA AND NORTH CAROLINIA.

Officer in charge, Col. William P. Craighill, Corps of Engineers.

1. *Channel to Baltimore, Maryland.*—The depth of this channel has been by successive steps increased from 17 feet at mean low water to 27 feet, with an average rise of tide of about 18 inches.

The project of improvement first adopted and commenced in October, 1853, had for its object to give a channel 22 feet at mean low water with a width of 150 feet.

Little was done before the late war, but afterwards these dimensions were increased, a depth of 24 feet at mean low water being determined upon with a width of channel ranging from 250 to 400 feet.

This channel was completed in 1874, important changes of position having been giving to a portion of it, by which the distance was materially lessened and the expense of maintenance decreased.

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The object of the improvement was to permit the approach to Baltimore, at mean low water, of vessels drawing from 22½ to 23 feet, and at ordinary high water of vessels drawing 24 and 24½ feet.

The last appropriation previous to 1884 was in August, 1882, $450,000, their being none in 1883.

This was expended in giving a depth of 27 feet in the Fort McHenry, Brewerton, and Craighill branches of the channel, and in the "Cut-off" between the Brewerton and Craighill branches.

For want of funds the work of improvement was entirely suspended during the whole of the year ending June 30, 1886.

The following were the widths of the respective branches of the channel June 30, 1886, with a depth of 27 feet at mean low water:

	Feet.
Craighill Channel	350
Cut-off Channel	300
Brewerton Channel	250
Fort McHenry Channel	250

With the appropriation of $150,000 of August 5, 1886, the channels have been widened, so that the following is true of them at mean low water:

Name of channel.	Width.	Depth.
		Feet.
Craighill, below Cut-off	400 feet	27
Cut-off	400 feet	27
Brewerton, above Cut-off	Generally 275 feet; a short portion 250 feet	27
Fort McHenry	250 feet, except for a length of 1,000 feet above lower end, where it is 300 feet.	27

Nothing has been done in the Craighill Channel above the Cut-off, or in Brewerton below it, for several years, and the depth of those portions is probably but 24 feet at low water. It is not expected to deepen these sections of the channel, as the deepening of the Cut-off to 27 feet makes it unnecessary. By the making of the Cut-off the lengths of the Craighill and Brewerton divisions of the channel are shortened, and thus the whole distance from Baltimore to the deep waters of the bay is materially lessened. The cost of maintenance is also decreased.

Though the depth of 27 feet at low water has been reached and seems to suffice for present needs, the width of the channel is still insufficient for easy or safe navigation by large vessels whose length is considerably greater than the width of the channel.

To give a uniform width of 400 feet throughout, with a depth of 27 feet at low water, will require $100,000. For the same depth the widths of 500 or 600 feet will cost, respectively, $650,000 and $1,300,000.

Up to June 30, 1888, the United States had expended $2,203,601.67, with the result indicated above. The city of Baltimore and the State of Maryland, chiefly the former, had also contributed to the same object more than $500,000.

Operations were suspended in June, 1887, for want of funds, and nothing was done except some surveys in the year ending June 30, 1888.

July 1, 1887, amount available	$12,798.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,772.82
July 1, 1888, balance available	4,025.49
Amount appropriated by act of August 11, 1888	300,000.00
Amount available for fiscal year ending June 30, 1889	304,025.49

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Amount (estimated) required for completion of existing project.....	$1,000,000.00
Amount that can be profitably expended in the fiscal year ending June 30, 1890.....	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 1.)

2. *James River, Virginia.*—When the improvement of the James River was regularly undertaken by the Government the navigation was obstructed by sunken vessels, by remains of military bridges, and by other obstructions put into the river during the late war to prevent the National fleets from approaching too close to Richmond.

There were also other natural obstructions. Rockett's Reef and Richmond Bar had only 7 feet of water at mean low tide. From Warwick Bar to Richmond the channel was crooked and obstructed by dangerous rocks and ledges, the Dutch Gap Cut-off was not then open and the river was in a poor condition as regards its availability for commercial purposes.

The original project of improvement was to secure a depth of 18 feet at full tide (corresponding to about 15 feet at low tide) to Richmond, with a channel width of 180 feet. This project had reached an advanced stage of progress when Congress, by act approved July 5, 1884, adopted the project looking to 22 feet at mean low tide from the sea to Richmond; the width to be 400 feet from the sea to City Point, 300 from thence to Drewry's Bluff, and 200 feet from thence to Richmond.

The failure of the river and harbor bill of 1885 restricted the operations of the year ending June 30, 1886, to the expenditure of less than $20,000 upon a project estimated to cost several millions. The condition of a year before was barely maintained. The total expenditure of the United States upon this river up to July 1, 1886, was $825,203.94. In addition the city of Richmond had spent nearly $500,000. The results of these expenditures may be stated as follows: Swan Point Shoal, where the depth had been only 16.5 feet at mean low tide, was deepened to 20 feet.

This increase of depth added a foot to the available depth of the river from its mouth to Kingsland Reach, a distance of 98 miles. The Dutch Gap Cut-off, which was originally of no use to navigation, had been widened to 300 feet, with a depth of about 18 feet, shortening the distance to Richmond 5½ miles. From Drewry's Bluff to the ship-locks at Richmond the depth had been increased from 7 feet at low tide to the present depth of about 13.5 feet at low tide.

July 1, 1886, the available balance was $2,559.27. The additional sum of $112,500 was provided by the law of August 5, 1886.

After the long suspension of active operations much time was consumed in bringing contractors to the work on reasonable terms. The available funds were expended by the end of December, 1887, in dredging at Kingsland Reach, Randolph Flats, and near Stearns Dike; in constructing training-walls and wing-dams at Randolph Flats, and in excavating rock at Goode's.

No very great effect could be expected from the expenditure of this small sum. The condition of the river at the close of the work may be stated as follows:

The available draught from the sea to City Point at high tide was 19½ feet; thence to Falling Creek, 19 feet; thence to Richmond, 16½ feet.

When the proposed improvement is completed, an annual expenditure of $20,000 will be necessary for the maintenance of the channel. The amount that may be advantageously expended during the fiscal

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year ending June 30, 1890, is put at $400,000, less than one-tenth the estimated cost of the adopted project.

Operations ceased in December, 1887, for want of funds, and the season of 1888 was more than half gone at the close of the fiscal year ending June 30, 1888, without anything being done or any preparations for work being possible.

The total amount expended on this river by the United States up to June 30, 1888, has been $939,215.23, which includes the sum of $208,330.68, expended since the new project has been entered upon to give a depth of 22 feet at mean low water.

July 1, 1887, amount available	$101,942.12
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	100,894.14
July 1, 1888, balance available	1,047.98
Amount appropriated by act of August 11, 1888	225,000.00
Amount available for fiscal year ending June 30, 1889	226,047.98
Amount (estimated) required for completion of existing project	4,161,070.45
Amount that can be profitably expended in fiscal year ending June 30, 1890	400,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 3.)

3. *Nansemond River, Virginia, including the mouths of Bennett and Chuckatuck creeks.*—From 1873 to 1878, inclusive, the expenditures made by the United States for the above improvement amounted to the sum of $37,000. The work consisted of removal of wrecks, snags, and similar obstructions, dredging at different localities, and building dikes at mouth of Western Branch. No work has been done since 1880.

In obedience to the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the river, and is printed in Appendix L 13 of the Report of the Chief of Engineers for 1887.

The plan of improvement proposed provides for a channel not less than 100 feet wide at bottom, 12 feet deep at mean low water from the head of navigation to the mouth of Western Branch, 5.37 miles, including a turning-basin 200 feet square, 300 feet below Suffolk Bridge, by dredging, and the construction of spurs and training-walls, and a channel of like depth from mouth of Western Branch to deep water at Town Point, 200 feet wide at bottom at its upper end and gradually increasing to at least 400 feet at its lower end, etc., the total estimated cost being in round numbers $152,500.

The river and harbor act of August 11, 1888, appropriates $10,000 for the work, and $15,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	142,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

4. *Harbor of Norfolk and its approaches, Virginia.*—Nothing has been done at this locality during the year ending June 30, 1888.

The project for improvement adopted in 1877 was to deepen and widen the channel at the mouth of the Southern Branch and along the Berkley and Portsmouth Flats, in the harbor proper, and for the ap-

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proaches to dredge a channel 500 feet wide and 25 feet deep at ordinary low water through the bars at the Western Branch and Sewell's Point.

The revised project of 1885 is as follows: (1) To secure a channel not less that 25 feet deep and 500 feet wide at ordinary low water, by dredging from the deep water of Hampton Roads to Norfolk and the United States navy-yard on the Southern Branch, and also to secure a channel in the Eastern Branch at the same stage, not less than 22 feet deep with a width at least 300 feet at the Norfolk and Western Railroad Bridge, and gradually increasing to about 700 feet at its mouth, by dredging between said points; and (2) to ultimately dredge the entire area bounded by lines parallel to and 75 feet from the Port Warden lines to a depth not less than 25 feet at ordinary low water, from Fort Norfolk to the United States navy-yard, and not less than 22 feet deep from the mouth of the Eastern Branch to Campostella Bridge, and to construct a bulk-head at Berkley Flats.

With slight modifications all operations have been conducted in accordance therewith. The amount expended to June 30, 1886, was $383,112.59, which resulted in a channel at least 25 feet deep and not less than 200 feet wide at ordinary low water, from the deep water of Hampton Roads to the United States navy-yard, and also a channel at least 22 feet deep and not less than 200 feet wide at same stage in the Eastern Branch up to the Norfolk and Western Railroad Bridge.

Cursory examinations show that the former channel is good, except at Sewell's Point, where it has contracted somewhat and shoaled in places. The ruling depth is 24 feet, save near Buoy No. 2, where it is 21 feet at mean low water. It is possible that the contemplated survey of this reach will determine that this portion of the straight dredged channel will have to be abandoned for the natural channel further inshore, which deep-draught vessels now navigate.

The Eastern Branch Channel has deteriorated slightly, the ruling depth being 21 feet at mean low water.

There was expended in the fiscal year ending June 30, 1887, $49,151.34, which was applied to the building of a steam-tender for use on this and other works and to the removal of 265,570 cubic yards of material, measured in scows, from the Southern Branch. This dredging resulted in a channel at least 25 feet deep and from 125 to 500 feet wide at mean low water, from its mouth to the upper end of the navy-yard.

To complete this work, so far as can be foreseen, will require the expenditure of $457,744.56.

July 1, 1887, amount available	$2,769.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,242.82
July 1, 1888, balance available	1,527.00
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	51,527.00
Amount (estimated) required for completion of existing project	407,744.56
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 4.)

5. *Approach to Norfolk Harbor and the United States (Norfolk) Navy-yard, between Lambert's Point and Fort Norfolk.*—Nothing has been done at this locality during the year ending June 30, 1888.

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The original condition of the channel was good, with the exception of a bar opposite the mouth of the Western Branch, on some parts of which the running depth was only about 15 feet at mean low water.

The project for the improvement adopted in 1878 was to dredge this bar for a distance of 4,800 feet to a width of 500 feet and a depth of 25 feet at mean low water.

The amount expended on this work to July 5, 1884, can not be stated, as it can not be separated from the sum total of the general expenditures for the work of improving the harbor at Norfolk, Va., and its approaches, of which this was a part up to that date.

The result obtained from the expenditures at this point to November, 1880, was a channel 4,400 feet long, 265 feet wide, and 25 feet deep at mean low water, which greatly facilitated navigation and commerce. This channel has since shoaled to 24 feet in places, and contracted considerably.

No work was done in this locality thereafter until subsequent to the passage of the act of July 5, 1884, which appropriated $50,000 specifically for widening the channel.

There was expended in the fiscal year ending June 30, 1885, $381.36, which was applied to surveying the locality in question and preparing map of same.

A Board of Engineer Officers was convened August, 1884, to prepare a project for the application of this appropriation. The Board reported a plan involving, in conjunction with dredging, the construction of a dike at or near Pinner Point, expressing at the same time doubts whether, under the phraseology of the law, any part of the money could be applied to a work of construction.

However, the requirements of navigation demanding the widening of the channel, as contemplated in the project already commenced and partly executed, by dredging, it was recommended that the existing appropriation be applied to widening the channel between Lambert's Point and Fort Norfolk by dredging along the eastern side thereof. This having been approved, the work was done accordingly.

There was expended in the fiscal year ending June 30, 1886, $46,768.64, which was applied to the removal of 469,944 cubic yards of material, measured in scows, resulting in a straight channel not less than 25 feet deep and at least 400 feet wide at mean low water the entire length of this approach. Formerly the channel had an angle in it. This work has materially benefited navigation and commerce.

There was expended in the fiscal year ending June 30, 1887, $32,348.92, which was applied to the building of a steam-tender for use on this and other works, and to the removal of 179,992 cubic yards of material, measured in scows, from the vicinity of Lambert's Point Light. This dredging resulted in a channel at least 25 feet deep and not less than 600 feet wide at mean low water from the main ship-channel to the Lambert's Point Coal Pier, about 1,000 feet.

Soon after the completion of this dredging, and as a preper precaution before commencing the proposed dike, the entire reach was resurveyed and a map of same made. This disclosed the fact that there existed a straight channel through it at least 25 feet deep and not less than 450 feet wide at mean low water, which had improved since it was dredged in 1885, and seemed to be self sustaining. The officer in charge reported accordingly, recommending that the construction of the dike be indefinitely postponed and that the money therefor be applied to additional dredging. The matter was referred to a Board of Engineer Offi-

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cers, and their report thereon was submitted to the Secretary of War, who directed, on June 15, 1887, that—

The money reserved for the dike will be held until the proper position of the dike can be determined, and the whole subject will be submitted to Congress at its next session.

July 1, 1887, amount available	$108,001.08
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	476.08
July 1, 1888, balance available	107,525.00
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	117,525.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	108,000.00

(See Appendix I 5.)

6. *Archer's Hope River, Virginia.*—Prior to the commencement of this work there existed a natural channel about 4 feet deep in the river, which could not be reached on account of the bar near its mouth, where it enters the James River.

The original project, adopted in 1881, is to dredge a channel 6 feet deep and not less than 50 feet wide from the mouth to Williamsburgh, 5 miles above, where it is crossed by the Chesapeake and Ohio Railroad.

The amount expended to June 30, 1884, is $9,874.79, which resulted in a channel 2,300 feet long, 6 feet deep, and 50 feet wide at mean low water from the mouth up. This did not carry the channel over the bar, which is 700 feet longer. No material benefit to navigation and commerce has yet been realized. There have been no operations since.

The small amount expended since June 30, 1887, has been applied to contingencies. The last examination, made in June, 1885, showed that the outer end of the dredged channel had shoaled about 1 foot, and that the inner part was in good condition.

July 1, 1887, amount available	$20.63
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20.63

(See Appendix I 6.)

7. *Appomattox River, Virginia.*—At the close of the late war the navigation of this river was in such a condition that the depth of water on more than one of the shoals did not exceed 6½ feet at high tide, and this depth was diminished by 3 feet at low tide. The plan of improvement adopted in 1870 was to attain a depth of 12 feet at high tide, with as much width of channel as the river would bear. This plan has been steadily adhered to, constant progress being made towards its completion from year to year by the use of the money granted by Congress. The means depended on have been revetments, jetties, dams, and training-walls, with resort to the dredge only when the needs of commerce required immediate work in the channel to give more width or depth than had been attained under the slower operations of the structures mentioned, of which the system has not yet been fully carried out for want of sufficient funds. Puddledock Cut, 2 miles long, has been enlarged, and the river was diverted from old channel into it. The amount expended by the United States up to June 30, 1886, on the project adopted in 1870, $381,234.24, resulted in securing a turning-basin at Petersburgh about 155 by 110 feet and a navigable channel of 12 feet and upwards at high tide, with some short shoals remaining from Petersburgh down to Point

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of Rocks, all of which vastly benefited navigation and largely increased the extensive commerce carried over this river.

The extraordinary freshet of July, 1886, caused the channel to deteriorate.

There was expended in the fiscal year ending June 30, 1887, the sum of $18,829.53, including outstanding liabilities, which was applied as follows: The river was resurveyed and mapped from the head of navigation to the natural deep water at Point of Rocks, 7⅛ miles, after which dredging, etc., was continued.

An aggregate of 25,047 cubic yards of material, measured in scows, was removed from the channel at Puddledock Cut, Rushmore's, and Gatling's shoals. A number of the jetties, dams, and training-walls outside the limits of Peterburgh Harbor were repaired more or less to preserve their efficiency. A revetment, 348 feet in length, was built along the left bank at the upper end of Puddledock Cut. The construction of Rushmore's training-wall, 607 feet long, and of Sunken Island Dam, 276 linear feet in length, was begun in the previous fiscal year and completed in July, 1887. The foregoing has resulted in generally obliterating the bad effects of the freshet and, it is believed, will guard against similar ones in future to any great extent. An annual expenditure of $5,000 will be required to maintain the work after the completion of the project, as is the case with all works of this class.

The principal portion of the work projected has been done, and in the main performs the service required of it. The condition of permanence of the deepened and improved channel seems to be nearly reached under the influence of its regulation. The truth of this statement is confirmed by the diminished use of the dredge year by year. The best results can not be said to be reached until its services can be dispensed with under ordinary circumstances.

July 1, 1887, amount available	$822.77
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	762.82
July 1, 1888, balance available	59.95
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,059.95
Amount (estimated) required for completion of existing project	18,810.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	18,900.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 7.)

8. *Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.*—Previous to the commencement of this improvement there was an indifferent natural channel with a depth of from 5 to 7 feet at low water, which had been partially dredged, in the sound and bay, by the Albemarle and Chesapeake Canal Company.

The original project, adopted in 1878, is to obtain a channel 80 feet wide at bottom and 9 feet deep at ordinary winter water, by dredging the entire length of the sound, 10½ miles, to which was added, in 1880, the project to prolong this channel by dredging through the bay about 2 miles, and to construct a shell dike 9,600 feet along the westerly side of the channel through the latter to maintain it. In 1885 it was further enlarged by the project to dredge a straight channel through North River Bar 7,150 feet long, 150 feet wide, and 9.4 feet deep at ordinary low water.

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The amount expended to June 30, 1885, is $123,500, and resulted in the construction of the dike and a channel in the sound and bay from 40 to 80 feet wide, the entire length and depth projected, all of which greatly improved navigation and increased the commerce over this important inland water route.

The entire channel was surveyed last in April and May, 1885, to ascertain its condition, which was found to be quite good, although shoaled in places. This is probably due very largely to steamers grounding out of the channel and creating shoals in their efforts to get off. To restore and complete the work will require the removal of 215,075 cubic yards of material measured in place.

There were no operations or expenditures during the fiscal year ending June 30, 1886.

There was expended during the fiscal year ending June 30, 1887, the sum of $1,729.20, including outstanding liabilities, $1,500 of which was applied to the building of a steam-tender for use on this and other works, and the balance to dredging. An attempt was made to dredge a channel across North River Bar, but, owing to the failure of the contractors to carry out their contract, very little was done.

The work was re-advertised and after much delay resumed by a new contractor, November 19, 1887. The appropriation was exhausted April 10, 1888. The result of the dredging was a channel 40 feet in width, 8,350 feet long, and 9.8 feet deep. To be useful such a narrow channel, more than a mile and a half long, should be carefully buoyed or otherwise distinctly marked. Owing to the exposure of the locality the permanence of the artificial channel is doubtful.

July 1, 1887, amount available	$9,770.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,456.48
July 1, 1888, balance available	314.32
Amount appropriated by act of August 11, 1888	7,500.00
Amount available for fiscal year ending June 30, 1889	7,814.32
Amount (estimated) required for completion of existing project	47,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I 9.)

9. *Nottoway River, Virginia.*—Prior to improvement the condition of this river at low water was as follows: At the mouth of the navigable depth was only 2 feet, due to sunken logs; thence to the Seaboard and Roanoke Railroad Bridge, 19 miles, the channel was from 9 to 25 feet deep and much obstructed by a war blockade of sunken vessels, and also by snags, overhanging growth, etc. The next reach, to Peter's Bridge, 31 miles, was so filled with snags, logs, etc., that it was with difficulty that a flat-boat of 1-foot draught could pass over it.

The original project, adopted in 1881, was to obtain a channel not less than 60 feet wide and at least 9 feet deep from the mouth to the railroad bridge, and 2 feet deep thence to Peter's Bridge, by removing the said obstructions.

The amount expended to June 30, 1882, is $6,420.30, which completed the project for the lower 29 miles. There have been no operations since.

This improvement has not led to the development of much trade on the river. There is no regular line of boats there. The river is crossed by the railroad and for some distance is paralleled, about 5 miles off, by the Blackwater River, on which are lines of steamers.

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The last examination, made in June, 1885, showed that the portion below the railroad bridge was in fair condition, while that above had again become obstructed by logs, etc., owing to the careless manner in which they had been handled and rafted. For this reason the river is not susceptible of entire and permanent improvement.

July 1, 1887, amount available	$246.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	246.16

(See Appendix I 11.)

10. *Removing sunken vessels or craft obstructing or endangering navigation.*—Notice was received February 3, 1888, that the wreck of the barge *Marion*, near Lambert Point lighthouse, Norfolk Harbor, Virginia, was a dangerous obstruction to navigation.

Correspondence with the owners, the Thames Towboat Company of New London, Conn., elicited the information that the company proposed to raise the barge. After much delay, the vessel was finally reported, May 14, 1888, completely removed without expense to the United States.

A petition from citizens of North Carolina for the removal of the wrecked schooner *Dorcas and Eliza* from the Pasquotank River, North Carolina, was received February 7, 1888. An examination of the wreck proved her to be dangerous to navigation. After advertisement for proposals for the removal, a contract was made with the lowest bidder, Mr. W. H. French, under date of April 6, 1888. The vessel was entirely taken up and the contract completed April 20, 1888.

Information was received March 9, 1888, that the sunken barge *Harry*, off Turkey Point, Chesapeake Bay, was in the track of vessels navigating those waters and dangerous to them.

Arrangements were made to advertise for proposals for her removal, but in the mean time the company having a marine risk on the vessel, The Phenix Insurance Company, of New York, showed a disposition to raise her. This was finally done May 4, 1888, without expense to the United States.

(See Appendix I 14.)

IMPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON; RECONSTRUCTION OF THE AQUEDUCT BRIDGE AT GEORGETOWN, AND CONSTRUCTION OF BRIDGE ACROSS THE EASTERN BRANCH OF THE POTOMAC RIVER AT WASHINGTON.

Officer in charge, Lieut. Col. Peter C. Hains, Corps of Engineers.

1. *Potomac River at Washington, District of Columbia.*—The project for the improvement of the Potomac River in the vicinity of Washington, D. C., was adopted by act of Congress passed August 2, 1882, and has for its object the improvement of the navigation of the river by widening and deepening its channels so as to accommodate vessels of the largest class that can reach Giesboro' Point; the establishment of harbor lines beyond which no obstructions, such as wharves, etc., should be built, and at the same time to fill and raise the marshes or flats in front of the city above overflow by the highest freshets, the material taken from the river in deepening and widening the channel to be used in filling the flats.

Before the improvement was commenced the flats or marshes in front of the city had become so offensive that certain parts of the city in their neighborhood were not habitable.

The channel to Georgetown was narrow and crooked, and had not

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sufficient depth to accommodate vessels sailing to and from that port. The Washington Channel between Long Bridge and the Arsenal was also inadequate to the wants of commerce. Vessels drawing 16 feet frequently grounded in the Georgetown Channel, and that depth was only maintained by frequent dredging.

The expenditures for the improvement have thus far amounted to $1,247,494.90, and have given a channel from Giesboro' Point to Georgetown about 500 feet wide and 20 feet deep (except where the depth has been somewhat reduced by the deposits of freshets), and a channel along the wharves from Washington Barracks 20 feet deep and about 350 feet wide. About 6,506,200 cubic yards of material have been deposited on the flats, raising an area of about 544 acres of marshes to a height of from 4 to 10 feet above mean low tide. More than half the entire work has been done at a total expenditure of $1,247,494.90, less than half the estimated cost of the entire work.

The dredging during the past year was done chiefly by contract. On Section II dredging in the Tidal Reservoir and in the Virginia Channel was in progress, and about three-fourths of the proposed excavation in the former is completed. All the material was deposited on the flats.

On Section III the construction of embankment was continued and completed; about 400,000 cubic yards of material were also excavated from the Washington Channel and deposited on this portion of the flats.

All the contracts for dredging and filling the flats have been completed, and no others have been made because of lack of funds.

The construction of the Reservoir Outlet has been in progress during the year, and the foundation for the main structure is now about completed. This has been a work of great difficulty owing to the soft nature, to a great depth, of the material forming the bed of the river at this place. The work is being done by hired labor.

The officer in charge refers to the necessity for action in regard to the sewer canal at the foot of Seventeenth street, as discussed in former reports. He also reports in regard to Section 1, that portion of the flats upon which work was stopped because of the requirement of Congress that no money should be expended upon any portion of the flats against which title claims adverse to the United States had been made, that certain work is necessary to secure the work already done from possible destruction, and recommends that the restrictions contained in the river and harbor act of August 5, 1886, and of the act approved August 5, 1886, be so modified as to permit of the necessary protective work.

Long Bridge and the necessity for Congressional action in regard to it is a prominent topic in the report of the officer in charge of this improvement. His report of February 11, 1888, upon the danger, not only to the improvement but to the city itself, from freshets and ice gorges, should Long Bridge be allowed to remain as it is, was transmitted to the Speaker of the House of Representatives by the Secretary of War (see House Ex. Doc. No. 170, Fiftieth Congress, first session).

The Long Bridge is controlled by the Baltimore and Potomac Railroad Company, being a free gift from the United States (as per act approved June 21, 1870). The officials of the railroad company claim that the improvement of the Potomac River will endanger that part of the structure spanning the Washington Channel. A conflict of interests seems probable, and the officer, while not of the opinion that the bridge will be endangered, recommends that Congress require the railroad company to erect such a structure at this place as will meet the new conditions.

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The amount of $600,000 can be profitably expended during the fiscal year ending June 30, 1890, in widening the channels of the river and raising the flats with the material excavated.

July 1, 1887, amount available		$250,361.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$222,856.50	
July 1, 1888, outstanding liabilities	1,970.40	
July 1, 1888, amount covered by existing contracts	2,410.00	
		227,236.90
July 1, 1888, balance available		23,124.70
Amount appropriated by act of August 11, 1888		300,000.00
Amount available for fiscal year ending June 30, 1889		323,124.70
Amount (estimated) required for completion of existing project		1,141,365.00
Amount that can be profitably expended in the fiscal year ending June 30, 1890		600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J 1.)

2. *Reconstruction of the Aqueduct Bridge, Georgetown, District of Columbia.*—Congress, by an act approved June 21, 1886, authorized the purchase of the Aqueduct Bridge, a wooden structure resting on stone piers, spanning the Potomac River at Georgetown, D. C., and appropriated $240,000 for that purpose and its reconstruction.

Certain claims, etc., affecting the title to the bridge being in existence when the bridge was conveyed to the Government, the interests of the United States were protected by the retention of a portion of the purchase money until the said claims were adjudicated. The officer in charge reports that the last payment on account of the purchase of the bridge has been made.

Proceedings have been instituted looking to the condemnation of the north abutment as provided in the act authorizing the purchase and reconstruction of the bridge. This matter is yet unsettled.

The bridge has been in course of reconstruction in accordance with the approved project which contemplated that an iron bridge having a clear width of roadway of 24 feet, with two sidewalks each 6 feet wide in the clear, be substituted for the old wooden superstructure which had become unsafe for travel. The new bridge was opened for public use on March 3, 1888. The contract for the reconstruction of the bridge proper was completed May 5, 1888. For several reasons, the principal of which was want of efficient management on the part of the contractor, this part of the work has taken a longer time than was thought necessary, though every effort was made on behalf of the United States to hasten its completion. There remains some work to be done on the approaches. This is in progress, under contract, and will be completed in the near future.

July 1, 1887, amount available		$122,712.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$98,262.66	
July 1, 1888, outstanding liabilities	9,210.10	
July 1, 1888, amount covered by existing contracts	4,110.75	
		111,583.51
July 1, 1888, balance available		11,128.86

(See Appendix J 2.)

3. *Bridge across the Eastern Branch of the Potomac River, District of Columbia.*—This work was authorized by act of Congress approved

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February 23, 1887, which appropriated $110,000 for the construction of a substantial wooden, iron, or masonry bridge, and provided that surveys be made to determine the length, width, and height thereof. The officer in charge made a report upon the survey, which was referred to a Board of Engineer Officers, which concurred in his recommendations that the direction of the bridge be a line forming an angle about six degrees to the southward of the line of Pennsylvania avenue extended, and that the width be not less than 32 feet, and the height of roadway 35 feet above low tide.

Bids were invited for a bridge possessing the above features, and a contract was made for the completion of the entire structure, including approaches, for a total price of $105,000.

Some time was lost in acquiring title to the site of the eastern approach, and some by reason of unfavorable weather, which hindered outdoor operations, but the chief cause of delay is a controversy with the Baltimore and Potomac Railroad Company, whose tracks are to be spanned by the westerly end of the bridge.

Congress by act approved May 14, 1888, made an additional appropriation of $60,000 to provide for modifying the plans so as to best accommodate traffic over and under the bridge, with a proviso that the Baltimore and Potomac Railroad Company pay their just and fair proportion of the cost of the changes at the west end.

A conference has been had for the purpose of adjusting the matter, but no agreement has been arrived at. Changes acceptable to the Government are regarded as too costly by the railroad company, while those meeting the wishes of the company, in regard to cost, do not provide for a construction acceptable to the Government.

July 1, 1887, amount available		$109,578.30
Amount appropriated by act of May 14, 1888		60,000.00
		169,578.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,713.70	
July 1, 1888, outstanding liabilities	8,659.71	
July 1, 1888, amount covered by existing contracts	89,050.15	
		108,423.56
July 1, 1888, balance available		61,154.74

(See Appendix J 3.)

4. *Wharf at Fort Monroe, Virginia.*—The act providing for the sundry civil expenses of the Government for the fiscal year ending June 30, 1887, appropriated $100,000 for the construction of a new wharf and improvements to the roadway leading thereto, on the Government reservation at Fortress Monroe. The selection of the most suitable site, and also of the plan and selection of the most suitable material for its construction, was referred to a Board consisting of Col. J. C. Tidball, First Artillery, Lieut. Col. J. G. Chandler, Deputy Quartermaster-General, and Lieut. Col. P. C. Hains, Corps of Engineers, whose recommendations were approved by the Secretary of War, and the work placed in charge of Lieutenant-Colonel Hains.

After some modifications of the plan, to reduce its cost, a contract was entered into for the work, and at the close of the fiscal year the greater part of the material had been prepared by the contractor and was being delivered at the site of the work.

(See Appendix J 5.)

5. *Survey of the James Creek Canal, emptying into Anacostia River, in the city of Washington.*—By direction of the Secretary of War, Lieutenant-

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Colonel Hains was directed to assume charge of the surveys and the preparation of plans and estimates for improving the low lands in the immediate vicinity of the Washington Barracks with a view to improving the sanitary condition of that post, the funds required for this purpose being provided by the Quartermaster-General's Department.

The report submitted of the results of this survey contains two plans of improvement suggested by Lieutenant-Colonel Hains, the details of which will be found in Appendix J 6.

IMPROVEMENT OF PATUXENT RIVER AND OF THE HARBORS AT BRETON BAY AND SAINT JEROME'S CREEK, MARYLAND—OF THE CHANNEL AT MOUNT VERNON—OF RAPPAHANNOCK RIVER, AND YORK RIVER, VIRGINIA—OF TRIBUTARIES OF THE LOWER POTOMAC, AND OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

Engineer in charge, Mr. S. T. Abert, United States Agent; Supervising Engineer, Col. W. P. Craighill, Corps of Engineers.

1. *Channel at Mount Vernon, Virginia.*—Previous to the commencement of this improvement there was a depth of but 4 feet at low water over the wide flat between the wharf at Mount Vernon and the main channel of the Potomac River, a distance of 1,900 feet. The present project, adopted in 1879, is to excavate a channel from deep water of the Potomac River to the wharf at Mount Vernon, which shall have, when completed, a width of 150 feet, and a navigable depth of from 6 to 7 feet at low water, with a turning-basin at the wharf.

The amount expended to the close of the fiscal year ending June 30, 1888, is $8,500.

A channel was secured 145 feet wide, with a depth varying from 7 to 9 feet, from the Potomac Channel to the wharf, and a circular turning-basin at the wharf, of the same depth, with a radius of 150 feet. No work has been done since 1881 and no examination has been made since that date, but a steamer drawing 4½ feet finds great difficulty in making a turn at the pier.

On the recommendation of the superintendent of Mount Vernon it is proposed, in the report of 1888, to increase the width to 200 feet and the depth to from 9 to 10 feet at low water, with a turning-basin of 200 feet radius. This modification is necessary to meet the requirements of trade during the period of low water, and will increase the estimate $2,500, making a total due on estimate of $8,500.

The engineer in charge believes that $8,500 will be necessary for widening the channel, enlarging the turning-basin, and removing the silt which has been deposited in the cut; that this sum will complete the improvement required by the present needs of navigation, and can be economically expended in the year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$6,000.00
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 1.)

2. *Neabsco Creek, Virginia.*—The obstruction to navigation in this stream consists of a wide flat at the mouth, about 1½ miles in length, over which but 2½ feet could be carried at low water, and several short bars in the upper part of the creek where the channel is narrow and tor-

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tuous. The present project was adopted in 1881, and contemplated the excavation of a channel through the bars, 100 feet wide and 7 feet deep at low water, from the Potomac River to Atkinson's Upper Landing (including a channel to Atkinson's Lower Landing and Willis's Wharf), a distance of about 14,800 feet.

The amount expended to the close of the fiscal year ending June 30, 1888, is $5,000. When work ceased in 1882 the channel was 50 feet wide and from 4 to 5 feet deep at low water from the Potomac River to a point 1,800 feet above Willis's Wharf.

Amount (estimated) required for completion of existing project.....	$20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 2.)

3. *Breton Bay, Leonardtown, Maryland.*—The harbor of Leonardtown, at the upper end of Breton Bay, prior to the commencement of the present improvement, had a least depth of 5 feet at low water, which was insufficient for the passage of steamers to and from the Leonardtown Wharf. The bar which extended to the 9-foot curve in the bay was about 1 mile in length.

The present project for the improvement, adopted in 1878 and modified in 1886, is to excavate a channel with a width of 200 feet for a distance of 1½ miles, and to enlarge the turning-basin to a breadth of 400 feet and a length of 800 feet. The depth is to be not less than 10 feet at low water.

Up to June 30, 1888, $29,173.96 have been expended. A basin has been secured 645 feet long by 370 feet wide, narrowing to a width of 150 feet in 335 feet; and a channel 150 feet wide for a distance of 1,870 feet, and 185 feet wide for a further distance of 1,420 feet. The depths vary from 8.5 to 13.3 feet at low water.

July 1, 1887, amount available.....		$992.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		666.33
July 1, 1888, balance available.....		326.04
Amount appropriated by act of August 11, 1888.....		3,000.00
Amount available for fiscal year ending June 30, 1889.....		3,326.04
Amount (estimated) required for completion of existing project		17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K 3.)

4. *Nomini Creek, Virginia.*—This stream is an important tributary of the Potomac, 82 miles below Washington. Navigation was obstructed by a bar of sand and oyster-shells at its mouth, over which but 3 feet could be carried at low water, and the approach to the bar was further obstructed by the cross-tide and an exceedingly rapid current. The length of the bar from the 9-foot curve in the river to the 9-foot curve in Nomini Creek is 5,700. After passing the bar 8½ feet can be carried to Nomini Ferry, 3 miles above the mouth.

The project, modified in 1885, is to cut a channel with a width of 200 feet, and also to dredge a training-channel and to sink a mattress for the purpose of diverting the cross-current. The depth should be not less than 10 feet at low water. The amount estimated in 1885 for this purpose was $30,000.

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The landings in Nomini Creek are the most important of those made by the Baltimore and Potomac River boats. Pilots find great difficulty in navigating the channel, and from their representations it is believed that the unfinished cut has filled from 30 to 40 per cent. since the date of the last dredging. It will, in consequence, be necessary to increase the estimate from $30,000 to $40,000, and this increase is recommended.

The amount expended to June 30, 1888, is $32,500, which resulted in securing a channel 100 feet wide and 9 feet deep from the 9-foot curve in the bay to White Oak Point, a distance of 4,400 feet.

No work has been done since 1882, and unless the channel is shortly redredged this creek must be closed to steamers.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 4.)

5. *Harbor at entrance of Saint Jerome's Creek, Maryland.*—The outer bar in the bay has a length of 2,193 feet from the 9-foot curve in the bay to Carsey's Point, in the creek. The least depth of water on it before improvement was 2.8 feet. The average depth in the channels to the ponds used by the Fish Commission for hatching oysters was one-half foot. The length of the inner channel to the wharf of the Fish Commission is 3,742 feet.

The project for the improvement of this harbor was adopted in 1881, and contemplated dredging a channel 100 feet wide and 9 feet deep at low water through the outer bar at the mouth of the creek; and a channel 40 feet wide and 6 feet deep through the south prong of the creek, the material therefrom to be thrown up in a dike so as to form a pond for the purposes of the United States Fish Commission. The channel through the outer bar was made navigable and the ponds were formed. The preservation of the depth on the outer bar is doubtful. This harbor is situated at a desirable point for a refuge for oyster-boats.

Up to June 30, 1888, $25,138.60 were expended.

July 1, 1887, amount available	$1,770.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	408.60
July 1, 1888, balance available	1,361.40
Amount (estimated) required for completion of existing project	26,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	18,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 5.)

6. *Patuxent River, Maryland, from Benedict to Hill's Landing.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination was made, and a survey of parts of the Patuxent River between the points designated.

A report of the results of the survey was transmitted to Congress February 14, 1888, and printed as House Ex. Doc. No. 162, Fiftieth Congress, first session.

The proposed improvement to consist of dredging a cut 200 feet wide and from 12 to 13 feet in depth, which will give, when completed, a channel of about 100 feet wide at low water, and 12½ feet in depth.

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The estimated cost for the two bars being about $80,000.

The river and harbor act of August 11, 1888 contains an appropriation of $5,000 for this improvement, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	75,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

7. *Rappahannock River, Virginia.*—The distance from Fredericksburgh to the mouth of the river is 106½ miles. The present project for the improvement of this river was adopted in 1871 and modified in 1879, the object being to provide a channel 150 feet wide and 10 feet deep through the bar at Fredericksburgh; channels 100 feet wide and 10 feet deep through the bars between Fredericksburgh and Port Royal; and channels 200 feet wide and 15 feet deep through two bars between Port Royal and Tappahannock, where a larger class of vessels must be provided for. Between March 3, 1871, and June 30, 1879, $90,500 were expended on the first project.

The amount expended on the present project from June 14, 1880, to June 30, 1887, is $81,278.76, and during the fiscal year ending June 30, 1888, $15,363.68, including outstanding liabilities, were expended, making a total to June 30, 1888, of $96,642.44. This amount has been expended in dredging, in the construction and repair of longitudinal and spur-dikes, in planting locusts and willows, and in the blasting and removal of rock. It has secured navigable channels at Fredericksburgh, Pollocks, Bernard's, Pratt's, Spottswood, Castle Ferry, and Farley Vale bars, extending over a distance of 12.6 miles. Between Fredericksburgh and Farley Vale the least depth on June 30, 1888, was 8 feet at low water, and the width about 100 feet. Below Farley Vale steamers have less difficulty in navigating the river.

July 1, 1887, amount available		$15,721.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$15,362.01	
July 1, 1888, outstanding liabilities	1.67	
		15,363.68
July 1, 1888, balance available		357.56
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,357.56
Amount (estimated) required for completion of existing project		179,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K 6.)

8. *Totusky River, Virginia.*—The obstructions to the navigation of this river consisted of two bars; one at its mouth, which forms a part of the wide flat between the outlet of the river and the navigable channel of the Rappahannock, having a least depth of 4½ feet, and the other, about 2½ miles above the mouth, known as Booker's Bar, having a ruling depth of 3 feet.

Ten thousand dollars were appropriated up to August 2, 1882. This sum has been expended in building and repairing a longitudinal dike

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2,117 feet in length, the effect of which has been to scour out the channel to a depth of 3½ feet at low water.

July 1, 1887, amount available	$400.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.82
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,000.00

(See Appendix K 7.)

9. *Urbana Creek, Virginia.*—Prior to the commencement of this improvement the navigation was obstructed by a bar at the mouth over which but 6 feet of water could be carried.

The present project was adopted in 1879, the object being to excavate a channel through the bar 150 feet wide and 10 feet deep at low water.

The amount expended to June 30, 1888, is $15,500.

The expenditure resulted in securing a channel of 10 feet in depth at low water and of 120 feet in width at the narrowest part through the outer bars. A turning-basin 200 feet wide, 300 feet long, and 10 feet deep has been made at the wharf, and also a channel of approach within the creek 1,090 feet long, 80 feet wide, and 10 feet deep at low water.

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	$7,000.00

(See Appendix K 8.)

10. *Mattaponi River, Virginia.*—This stream is navigable for 56 miles. Previous to the commencement of the improvement the river was obstructed by numerous bars and by snags, wrecks, and overhanging trees. The object of the improvement adopted in 1880 was to provide a channel 40 feet wide and 5½ feet deep at low water by the removal of snags, drift-logs, wrecks, and overhanging trees, and by dredging through the bars. The channel through Robinson and Latané's bars will have a width of 40 feet at bottom and a depth of 6 feet at low water. The amount expended to June 30, 1887, is $7,201.32, and during the year ending June 30, 1888, $5,981.98 have been expended, making a total to June 30, 1888, of $13,183.30. This sum was expended in snagging operations and the removal of wrecks, logs, and overhanging trees for a length of river of about 34 miles and in building a dike at Robinson's Bar.

July 1, 1887, amount available		$6,098.68
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,980.09	
July 1, 1888, outstanding liabilities	1.89	
		5,981.98
July 1, 1888, balance available		116.70
Amount appropriated by act of August 11, 1888		3,000.00
Amount available for fiscal year ending June 30, 1889		3,116.70
Amount (estimated) required for completion of existing project		23,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K 9.)

11. *Pamunky River, Virginia.*—The present project was adopted in 1880, the object being to provide a channel 40 feet wide and from 3 to 5

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feet deep from Hanovertown to New Castle Ferry, a distance of 9 miles, and 100 feet wide and 7 feet deep at low water on two of the lower bars.

The total expenditure to June 30, 1887, is $6,457.47, and during the fiscal year ending June 30, 1888, $5,943.50 have been expended, making a total to June 30, 1888, of $12,400.97. This sum was expended in the removal of snags, wrecks, logs, and overhanging trees from 16½ miles of the river and in building dikes at Skidmore and Spring bars.

July 1, 1887, amount available	$6,042.53
July 1, 1888, amount expended during fiscal year, exclusive of liabities outstanding July 1, 1887	5,943.50
July 1, 1888, balance available	99.03
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,099.03
Amount (estimated) required for completion of existing project	13,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,000.00
Submitted in compliance with requirments of sections 2 of river and harbor acts of 1866 and 1867.	

(See appendix K 10.)

12. *York River, Virginia.*—The navigation of the river prior to the commencement of the present improvement was obstructed by a bar at the mouth of Potopotank Creek, having a least depth of 19 feet at low water; and a bar about 8½ miles above at West Point, Va., having a least depth of 14 feet.

The present project was adopted in 1880, the object being to provide a channel 22 feet deep at low water, and 400 feet wide through the bars; and also a basin of the same depth, connecting with the channel above the wharves.

The first appropriation ($10,000), made June 14, 1880, was applied to the improvement of Potopotank Bar, through which a channel 105 feet wide and 22 feet deep was made by dredging. The appropriations since 1880 have been applied to dredging a channel below West Point.

The amount expended up to June 30, 1888, is $95,348.62. The expenditures at West Point have resulted in giving a channel 190 feet wide for a distance of 750 feet; 230 feet wide for a distance of 2,060 feet; 190 feet wide for a distance of 6,290 feet; 180 feet wide for a distance of 1,200 feet, and 100 feet wide for a distance of 1,000 feet, all distances being stated successively and in a descending order. The depth in the channel varies from 17.8 to 25.6 feet at low water.

The width, when the channel is completed, will be 400 feet, and the depth at low water will be 22 feet, which dimensions will be necessary for vessels beating up to West Point.

July 1, 1887, amount available	$3,656.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	254.90
July 1, 1888, balance available	3,401.38
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	33,401.38
Amount (estimated) required for completion of existing project	127,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 11.)

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13. *Chickahominy River, Virginia.*—The present project was adopted in 1878, the object being to dredge channels from 100 to 150 feet wide through Windsor Shades, Old Fort, and Binn's bars, to a depth of not less than 8 feet at low water. The whole of the appropriations, amounting to $19,000, have been expended.

On June 30, 1887, the bars at Windsor Shades and Old Fort had a depth of from 8 to 9 feet and a width of about 75 feet. At Binn's Bar the depth was between 7½ and 8½ feet, and the width about 160 feet. The channel through the bar at the mouth had a width of about 200 feet and a depth of from 14 to 15 feet. The depths given refer to low water. The length of the cut through the bar at the mouth of the river is 1,700 feet.

For the completion of the project for the improvement of the upper part of the river, and for re-examinations of the old bars and the new ones which have formed since the commencement of the work, $10,000 are required.

Amount appropriated by act of August 11, 1888	$2,500.00
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K 12.)

14. *Staunton River, Virginia.*—The project for the improvement of this river between Brook Neal and Randolph Station, 31 miles below, on the Richmond and Danville Railroad, was adopted in 1879, the object being to secure a navigable channel, not less than 35 feet wide and 2 feet deep at low water, through the various ledges and sand-bars, which obstruct navigation.

The amount expended to June 30, 1887, is $29,006.67, and during the fiscal year ending June 30, 1888, $3,105.33 have been expended, making a total to June 30, 1888, of $32,112.00.

About 29½ miles of the river have been opened for navigation by small steamers.

The project for the improvement of the part of the river between Pig River and Brook Neal was adopted in 1882, the object being to secure a navigable channel for bateaux, not less than 14 feet wide and from 1½ to 2 feet deep at low water, with a slope of water-surface at rapids not greater than 10 feet to the mile.

The amount expended to June 30, 1887, is $3,606.77, and during the fiscal year ending June 30, 1888, $2,966.27, including outstanding liabilities, were expended, making a total to June 30, 1888, of $6,573.04. This expenditure resulted in opening a channel from the railroad bridge to a distance of 18¼ miles above.

July 1, 1887, amount available		$6,886.56
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,068.60	
July 1, 1888, outstanding liabilities	3.00	
		6,071.60
July 1, 1888, balance available		814.96
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,814.96
Amount (estimated) required for completion of existing project		58,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K 13.)

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15. *Dan River, between Madison, North Carolina, and Danville, Virginia.*—The object of the first project for this improvement, adopted in 1880, was to provide a channel for navigation not less than 35 feet wide, but it was afterwards modified to a channel of not less than 16 feet wide and 2 feet deep in the rapids at low water. The amount expended to June 30, 1887, is $36,789.92, and during the fiscal year ending June 30, 1888, $13,298.89, including outstanding liabilities, were expended, making a total to June 30, 1888, of $50,088.81. This expenditure has resulted in the excavation of rock from the channel between Madison and Danville and in building crib-dams at Slink's Shoals. The amount due on estimate will be expended in building dams at the falls of greatest descent, in excavating gravel-bars, and in rock excavation below Eagle Falls.

July 1, 1887, amount available		$13,710.08
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$12,558.96	
July 1, 1888, outstanding liabilities	739.93	
		13,298.89
July 1, 1888, balance available		411.19
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		7,000.00

(See Appendix K 14.)

16. *Roanoke River, North Carolina.*—The first project for the improvement of this river was made in 1871, the object being to improve navigation by the removal of rocks near Weldon and Halifax, and all wrecks, snags, and overhanging trees at various other points; and to dredge channels through the numerous bars and shoals. A part only of this project was adopted.

The appropriation of $5,000, made August 2, 1882, was expended in repairing two dikes at Indian Highland Bar. A survey was also made to ascertain the changes which had taken place since 1871.

The amount expended under the first project to June 30, 1884, was $45,000, and was chiefly for the removal of wrecks and blockades, and for blasting rock near Weldon. The first appropriation under the present project ($3,000, made July 5, 1884) was not sufficient to prosecute the work economically. With the $20,000 appropriated August 5, 1886, it was applied to building and operating a steam-plant. Coshake Creek for its whole length, 1½ miles, and the Thoroughfare, a distance of 2 miles, were cleared of obstructions; 10.5 miles of the river channel were wholly cleared, and 10.8 miles partially cleared of obstructions. In all, about 25 miles of channel were improved.

The appropriations for the present project to June 30, 1888, amount to $23,000. Of this sum, $8,978.34 were expended to June 30, 1887; and during the year ending June 30, 1888, $11,457.38, including outstanding liabilities, were expended, making a total to June 30, 1888, of $20,435.72.

July 1, 1887, amount available		$14,021.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,364.65	
July 1, 1888, outstanding liabilities	92.73	
		11,457.38
July 1, 1888, balance available		2,564.28
Amount appropriated by act of August 11, 1888		40,000.00
Amount available for fiscal year ending June 30, 1889		42,564.28

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Amount (estimated) required for completion of existing project $160,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 45,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix K 15)

17. *French Broad River, North Carolina.*—The first project for the improvement of this river was adopted in 1878, the object being to secure a channel 35 feet wide and not less than 2½ feet deep at low water between Brevard and Big Buck Shoals, a distance of 31.6 miles.

The amount expended to June 30, 1882, was $37,780.22, with the following results: A survey of the river between Brevard and Big Buck Shoals; the improvement of the various shoals and rapids by means of rock and gravel excavation, and the construction of wing dams for a distance of 26 miles below Brevard.

The act of August 2, 1882, appropriated $5,000 for improving the river "from Smith's Bridge up." A survey from Smith's Bridge (near Asheville) to the foot of Long Shoal, a distance of 12.09 miles, was made in 1882, and a project adopted for securing a channel 30 feet wide and not less than 2¼ feet deep at low water for this distance. The estimates amounted to $76,000. In the fiscal year ended June 30, 1884, this part of the river was improved for a distance of 4½ miles above the bridge, under a special act of appropriation.

The amount expended to June 30, 1888, is $43,000.

Amount (estimated) required for completion of existing project $79,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix K 16.)

18. *Removing sunken vessels or craft obstructing or endangering navigation.*—The wreck of the schooner *Spray*, abandoned by her owners and beached in 1885, was reported on April 14, 1887, as an obstruction to navigation. The usual notice of thirty days to persons interested was published, and proposals were opened June 6, 1887.

The lowest bidder exceeded the amount ($1,100) allowed by the Secretary of War. Authority was obtained June 13, 1887, and in July of the same year, for the sum allotted, the wreck was removed by hired labor with the steam-plant belonging to the Rappahannock River improvement.

Three wrecks, near Ayletts, in the Mattaponi River, Virginia, were reported on February 23, 1888, as obstructions to navigation.

The usual notice of thirty days to persons interested was published, and proposals were opened April 28, 1888. Mr. William H. French, of Norfolk, Va., was the lowest bidder, and a contract was made with him for $1,800, the work to be completed by August 9, 1888.

The work of removal commenced June 12, 1888, and was completed according to the specifications during the month.

(See Appendix K 17.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the locality was worthy of improvement, Mr. Abert was charged with and completed the following survey, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 162, Fiftieth Congress, first session.

1. *Patuxent River, Maryland, from Benedict to Hill's Landing.*—(See also Appendix K 18.)

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IMPROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

Officer in charge, Capt. W. H. Bixly, Corps of Engineers, having under his immediate orders First Lieut. H. Taylor, Corps of Engineers. Supervising engineer, Col. W. P. Craighill, Corps of Engineers.

1. *Pamlico and Tar rivers, North Carolina.*—The Pamlico and Tar rivers are different portions of a single stream, the upper portion being called the Tar.

When placed under improvement in 1876, the Pamlico River had an available depth of only 3 feet at low water in its upper portion, near Washington. The Tar River had during eight months of the year an available depth of from 2 to 3 feet for 49 miles up to Tarborough, its practical limit of navigation. The channel of the combined stream was almost completely obstructed by two war blockades, and by floating and sunken stumps and logs, and by overhanging trees.

The original project of 1876 (for the Pamlico) and of 1879 (for the Tar), as since slightly modified and continued to date, proposed to secure a clear channel 9 feet deep at low water up to Washington; thence a channel 60 feet wide and 3 feet deep at low water, 23 miles further to Greenville, and thence a channel 60 feet wide and 20 inches deep, 26 miles further to Tarborough. The final total cost of this work was estimated in 1887 to be $75,000. These estimates have since been increased to $76,000. The total amount appropriated up to June 30, 1888, is $58,000, the appropriation for the two rivers being consolidated in 1880.

During the fiscal year ending June 30, 1888, $1,663.72, including outstanding liabilities, was spent in removing dangerous obstructions from the portion of the river from 5 miles above to 4 miles below Greenville, where navigation was most obstructed, and in caring for property, etc. All work in the field was stopped in September, 1887, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $57,776.33 has been spent upon this improvement in securing a good channel at least 9 feet deep at low water and at least 108 feet wide from Pamlico Sound, 37 miles, up to Washington; thence a fair channel 60 feet wide and 3 feet deep all the year, 23 miles, to Greenville, and thence a similar channel for eight months of the year, 26 miles, to Tarborough.

After the improvement is finished, its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1887, amount available		$1,887.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,653.39	
July 1, 1888, outstanding liabilities	10.33	
		1,663.72
July 1, 1888, balance available		223.67
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,223.67
Amount (estimated) required for completion of existing project		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 1.)

2. *Contentnia Creek, North Carolina.*—When placed under improvement in 1881 this stream had a depth of about 3 feet, during nine

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months of the year, from its mouth in the Neuse upward about 63 miles to Stantonsburgh, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps, and by floating obstructions.

The original project of 1881, as continued to date, proposed to secure a safe and unobstructed 3-foot navigation over this distance during the high-water season of about nine months. The final total cost of this work was estimated in 1885 at $75,000. These estimates have since been increased to $77,500. The total amount appropriated up to June, 30, 1888, is $40,000.

During the fiscal year ending June 30, 1888, $5,529.59, including outstanding liabilities, was spent in removing dangerous obstructions over the entire length of the improvement (mainly in the upper portion of the river), and in care of property, etc. All work in the field was stopped in March, 1888, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $39,548.68 has been spent in securing a moderately well-cleared 3-foot navigation over the 31 miles from its mouth up to Snow Hill, and a roughly-cleared 3-foot navigation over 32 miles further to Stantonsburgh, during the high-water season. In consequence of this two steamers make bi-weekly trips to Snow Hill during nine months of the year, and flats ply between Snow Hill and Stantonsburgh. The present commerce is about $800,000, and is rapidly increasing.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1887, amount available		$5,980.91
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,518.32	
July 1, 1888, outstanding liabilities	11.27	
		5,529.59
July 1, 1888, balance available		451.32
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,451.32
Amount (estimated) required for completion of existing project		32,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 2.)

3. *Trent River, North Carolina.*—When placed under improvement in 1879 this river had a 6-foot to 8-foot roughly-cleared navigation from its mouth, at New Berne, up 21 miles to Pollocksville, and a light-draught navigation 9 miles further to Quaker Bridge. Above Pollocksville the bars, snags, and trees prevented all navigation, except occasionally by small flat-boats during high freshets.

The original projects of 1879 to 1880, as continued to date, assumed that 6 to 8 feet of water could be carried at all stages from its mouth 21 miles to Pollocksville, and proposed to secure a thoroughly cleared 3-foot navigation, with at least 50 feet channel width at all stages of water, from Pollocksville 22 miles up to Trenton, the practical limit of steam-boat navigation, using the balance of the funds to improve the channel from its mouth, 30 miles upwards to Pollocksville and Quaker Bridge. The final total cost of this work was estimated in 1885 at $56,500. These estimates have been increased to $59,000. The total amount appropriated up to June 30 is $45,500.

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During the fiscal year ending June 30, 1888, $673.25, including outstanding liabilities, was spent in removing the few dangerous obstructions which had fallen into the river during the preceding year, and in caring for property, etc. Work in the field was carried on only from October 20 to December 9, 1887. The most important work to be done was that of dredging and blasting at Foy's Flats. Attempts were made all during the year to hire the dredging or a suitable dredge, but the amount of funds available for this work was so small that nothing could be obtained at any advantageous terms. Consequently further work awaits future appropriations.

Up to June 30, 1888, a total of $42,704.98 has been spent in all upon this improvement, in securing a moderately well-cleared 6-foot to 8-foot navigation at all stages (8 to 9 feet at ordinary stages) from New Berne 30 miles up to Quaker Bridge; and thence a thoroughly-cleared 3-foot navigation at least 50 feet wide at all stages 13 miles further to Trenton, and an excellent turning-basin at Trenton. In consequence of this improvement, a steam-boat navigation has been permanently established over the entire river to Trenton.

The proper maintenance of the improved channel may cost from $1,000 to $2,000 per year.

July 1, 1887, amount available		$3,468.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$576.38	
July 1, 1888, outstanding liabilities	96.87	
		673.25
July 1, 1888, balance available		2,795.02
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,795.02
Amount (estimated) required for completion of existing project		8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 3.)

4. *Neuse River, North Carolina.*—When placed under improvement in 1878 this river had during nine months of the year a 9-foot depth of channel from its mouth 40 miles up to New Berne, thence a 4-foot depth 50 miles further to Kinston, thence a 3-foot depth 46 miles further to Goldsborough, and thence a 2-foot depth 62 miles further to Smithfield, this channel depth being reduced during the low-water season to 8 feet at New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the whole 198 miles the river was so blocked by war and other obstructions that navigation was impracticable.

The original projects of 1871 for below Goldsborough, and of 1879 for above Goldsborough, contemplated the removal of the war blockades and natural obstructions and the excavation of a few cut-offs, so as to get 4.5 feet at low water all the year to Goldsborough, and 3 feet during nine months to Smithfield. The projects of 1878, 1880, and 1883, as continued to date, propose to remove all sunken logs, snags, floating, and other obstructions, and to contract the channel-way by jetties, so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston, and during nine months of the year a 3-foot navigation 108 miles further to Smithfield. The final total cost of this work was estimated in 1885 at $370,000.

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These estimates have been increased to $374,000. The total amount appropriated therefor up to June 30, 1888, is $232,500.

During the fiscal year ending June 30, 1888, $5,977.22, including outstanding liabilities, was spent in contracting by jetties about one-half mile of the river between Kinston and New Berne, in removing dangerous obstructions from 59 miles of river just above and below Kinston, in rebuilding plant, and in caring for property, etc.

Up to June 30, 1888, a total of $226,017.60 has been spent in all upon this improvement, giving a moderately well-cleared channel over the entire length of the river, allowing an 8-foot navigation 40 miles to New Berne, and a 3-foot navigation 50 miles further to Kinston all the year; also a fair 3-foot navigation 46 miles further to Goldsborough during nine months per year, and still 62 miles further to Smithfield six months per year.

After the improvement is finished its proper maintenance may cost from $2,000 to $6,000 per year.

July 1, 1887, amount available		$12,459.62
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,732.32	
July 1, 1888, outstanding liabilities	244.90	
July 1, 1888, amount covered by existing contracts	1,650.00	
		7,627.22
July 1, 1888, balance available		4,832.40
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		19,632.40
Amount (estimated) required for completion of existing project		126,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 4.)

5. *Inland water-way between New Berne and Beaufort, North Carolina.*—The inland line of navigation from New Berne to Beaufort Harbor, *via* Clubfoot, Harlowe, and Newport rivers, was established by the State of North Carolina about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned. This line, about 42 miles in total length, extends from New Berne about 23 miles down the Neuse River, 6 miles up Clubfoot River, 3.21 miles through the Clubfoot and Harlowe Canal, 3.5 miles down Harlowe River, and 6 miles through Newport River to Beaufort Harbor. About 1880 the line was re-opened by the New Berne and Beaufort Canal Company.

When placed under improvement in 1885, this route allowed the passage of small boats of 15 feet width and 3 feet draught, but the commerce was practically nothing.

The original project of 1883 reported this route as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward, and estimated the cost of a channel 80 feet wide and 9 feet deep at $883,580, increased by the cost of a tide-lock and the canal company's franchise.

A modified project of 1884 for the expenditure of the funds then available, as continued to date, proposed to widen and deepen Harlowe Creek so as to secure a through canal of 5 feet depth at mean low water, and of 30 feet bottom width from the mouth of Harlowe Creek upwards 3.25 miles to its head, and to use the remaining funds upon similar works upon Clubfoot River. The total final cost of this latter project (includ-

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ing also the continuation of the same work through the canal) was estimated in 1886 at $92,000. The total amount appropriated therefor up to June 30, 1888, is $20,000.

During the fiscal year ending June 30, 1888, $3,313.20, including outstanding liabilities, was spent in inspection and superintendence, in care of property, etc., and in widening and deepening Harlowe Creek to the proposed dimensions over a length of 873 feet, the dredging having been done under contracts still in force.

Up to June 30, 1888, a total of $6,812.45 has been spent in all upon this improvement, on necessary surveys, in the removal of the worst logs and stumps in the existing channel, and in dredging the creek to 30 feet width and 5 feet depth at low water over a length of 873 feet, and to a width and depth through the entire creek sufficient to allow the passage of small sail-boats. In consequence of this, several hundred sail-boats have been passed through the canal, and the commerce of this route, now about $190,000, is rapidly increasing. If the improvement is completed it will be of much value as a connecting link between Pamlico Sound and Beaufort Harbor, and would complete an otherwise already existing inland navigation from the Chesapeake to Beaufort, N. C.

After the proposed channel is opened its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1887, amount available		$16,500.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,743.87	
July 1, 1888, outstanding liabilities	569.33	
July 1, 1888, amount covered by existing contracts	12,667.65	
		15,980.85
July 1, 1888, balance available		519.90
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,519.90
Amount (estimated) required for completion of existing project		57,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 5.)

6. *Harbor at Beaufort, North Carolina.*—This harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of any importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles.

When placed under improvement in 1880 it possessed a bar entrance of 15.3 feet least depth at mean low water, with an average rise and fall of tide of 3 feet. At this time, however, the northern entrance was rapidly deteriorating; its width, measured from Fort Macon Point to Shackleford Point, having increased 500 feet between the years 1864 and 1880, and 900 feet more between the years 1880 and 1881, and its bar having rapidly and proportionally shoaled. From the bar the harbor possessed a channel of 25 feet depth upwards for 3.7 miles to the Atlantic and North Carolina Railroad Wharf at Morehead City, and a branch channel of 9 feet depth for six-tenths of a mile up to Bulkhead Channel, and of 2 feet minimum depth for six-tenths of a mile further to the wharves of Beaufort City, where coasting vessels had a good wharfage of 7 feet depth and 1,800 feet length.

The projects of 1881, 1882, and 1884, as continued to date, proposed to secure this harbor by stopping further erosion of the sand-banks at

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Shackleford Point and Fort Macon Point, and thus stopping further deterioration of the bar entrance, and proposed to open a 5-foot channel 100 feet wide to Beaufort City. The total final cost of this work was estimated in 1887 at $163,000. The total amount appropriated therefor up to June 30, 1888, is $90,000.

During the fiscal year ending June 30, 1888, $5,783.29, including outstanding liabilities, was spent in strengthening existing jetties at Shackleford Point and Fort Macon Point, in building catch-sand fences at Fort Macon Point, in minor surveys, and in care of property, etc. All work in the field, except some slight necessary repairs to the main jetty at Shackleford Point, was stopped in October, 1887, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $88,869.48 has been spent in all upon this improvement, in successfully stopping the erosion of Shackleford Point and Fort Macon Point, in probably arresting the shoaling upon this bar, and in making a survey of the present condition of the harbor entrance preparatory to the definite location of future works. No special improvement of commerce nor depth of water was thereby expected or obtained, but the retrograde movement has been in general arrested, the old shore-lines have commenced to reform as desired, and the former good condition of the harbor is being rapidly re-established.

The improvement, once thoroughly finished, should be comparatively permanent.

July 1, 1887, amount available		$6,913.81
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,617.67	
July 1, 1888, outstanding liabilities	165.62	
		5,783.29
July 1, 1888, balance available		1,130.52
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,130.52
Amount (estimated) required for completion of existing project		38,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		38,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 6.)

7. *Inland water-way between Beaufort Harbor and New River, North Carolina.*—When placed under improvement in 1886 there was a channel 18 inches deep at low water from Beaufort to the town of Swansborough, on White Oak River; thence a 3-foot depth at mid-tide, 6 miles further to Bear Inlet and Creek; thence a 6-inch depth at low water 11 miles further to New River, whence boats of 5 feet draught could proceed 14 miles further to the town of Jacksonville. Its commerce was then about $200,000 per year.

The original project of 1885, as continued to date, recommended the establishment of a channel of at least 3 feet depth at low water from Beaufort to Swansborough. The total final cost of this work was estimated in 1887 at $50,000. The total amount appropriated therefor up to June 30, 1888, is $10,000.

During the fiscal year ending June 30, 1888, $6,265.94, including outstanding liabilities, was spent in inspection and superintendence, in care of property, etc., and in dredging the proposed channel-way to partial width and depth under contracts still in force.

Up to June 30, 1888, a total of $6,676.51 has been spent upon this improvement in securing a channel-way of at least 40 feet width and of

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3 feet depth at low water, part way from Beaufort Harbor to Swansborough.

The improvement, once thoroughly finished, should be comparatively permanent.

July 1, 1887, amount available		$9,589.43
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,573.19	
July 1, 1888, outstanding liabilities	2,692.75	
July 1, 1888, amount covered by existing contracts	2,595.97	
		8,861.91
July 1, 1888, balance available		727.52
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,727.52
Amount (estimated) required for completion of existing project		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 7.)

8. *New River, North Carolina.*—When placed under improvement in 1882, this river had very poor facilities for transporting goods to market. Its outlet to the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water.

The original project, as continued to date, proposed to secure a 150-foot channel, 5 feet deep at low water, from the upper river to the ocean, by dredging. The total final cost of this work was estimated in 1885 at $40,000. The total amount appropriated up to June 30, 1888, is $20,000.

During the fiscal year ending June 30, 1888, $8,191.37 was spent in inspection and superintendence, in care of property, and in dredging the proposed channel to partial width and depth. All work in the field was stopped in February, 1888, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $18,183.41 has been spent in all upon this improvement, in replacing the long and crooked channel by a shorter and straighter channel of at least 40 feet bottom width and 3.5 feet depth at low water. The new channel is already in daily use by the craft entering New River from the ocean, and is steadily deepening under the scour of the river and tidal currents.

This improvement, once thoroughly completed, should be permanent.

July 1, 1887, amount available	$10,007.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,191.37
July 1, 1888, balance available	1,816.59
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	4,816.59
Amount (estimated) required for completion of existing project	17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L 8.)

9. *Black River, North Carolina.*—When placed under improvement in 1886, this river had a moderately well cleared channel from its mouth (in the Cape Fear River, 14 miles above Wilmington) 22 miles upwards

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to Point Caswell, with 2.5 feet depth at low-water and 4 feet depth at high tide, thence a roughly cleared navigation 48 miles further to near Lisbon, with 2.5 feet depth during nine months per year and with 6 feet depth during six months per year.

The original project of 1885, as continued to date, proposed to secure a fairly cleared natural channel over the entire river from its mouth up 70 miles to near Lisbon, then a 4-foot channel below Point Caswell, and then an improved channel through the Narrows. The total final cost of this work was estimated in 1885 at $33,500. The total amount appropriated up to June 30, 1888, is $3,000.

During the fiscal year ending June 30, 1888, $2,224.61, including outstanding liabilities, was spent in removing the worst obstructions from the channel and banks of 43 miles of river above Point Caswell, and in care of property, etc. All work in the field was stopped in January, 1888, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $2,267.31 has been spent upon this improvement in the removal of the worst obstructions over the entire river.

After this improvement is finished, its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1887, amount available		$2,957.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,211.41	
July 1, 1888, outstanding liabilities	13.20	
		2,224.61
July 1, 1888, balance available		732.69
Amount (estimated) required for completion of existing project		30,500.00
Amount that can be profitably expended in fiscal year ending June, 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		10,000.00

See Appendix L 9.)

10. *Cape Fear River, North Carolina.—Above Wilmington.*—When placed under improvement in 1881 the Cape Fear River above Wilmington was navigable during the nine months of the year from Wilmington 112 miles upwards to Fayetteville, but the channel for the upper 75 miles was badly obstructed by logs, snags, overhanging trees, and shoals, and for the upper 66 miles it was full of shoals on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned by private parties.

The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river for $10,000, then to clear out its natural obstructions and to further provide a continuous channel over its upper 66 miles by dredging and by artificially contracting its waterways through at least thirty-two shoals. The total cost of this work was estimated in 1885, by the officer in charge, at $480,000 for a 3-foot actual channel depth up to Fayetteville during eleven or twelve months of the year. The total amount appropriated up to June 30, 1888, is $76.250.

During the fiscal year ending June 30, 1888, $8,054.08, including outstanding liabilities, was spent in removing all the dangerous obstructions within the limits of the improvement, in contracting the channel by jetties along about a mile length of the river between Elizabethtown and Fayetteville, and in repair and care of property, etc. All work in the field was stopped during a large part of the year because the available funds were not sufficient for continuous advantageous work.

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Up to June 30, 1888, a total of $73,887.02 has been spent in all upon this improvement, giving a moderately well cleared channel over the whole length of the river, a moderately good 4-foot continuous channel during the entire year from Wilmington, 44 miles, to Kelly's Cove; thence a similar 2-foot channel 26 miles further to Elizabethtown, and thence a similar 1-foot channel 42 miles further to Fayetteville, increased to 5-foot draught from Wilmington to Fayetteville during seven months of the year.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

July 1, 1887, amount available		$10,417.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,460.32	
July 1, 1888, outstanding liabilities	1,559.36	
		8,019.68
July 1, 1888, balance available		2,397.38
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		14,397.38
Amount (estimated) required for completion of existing project		188,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 10.)

At and below Wilmington.—When placed under improvement in 1829 the Cape Fear River below Wilmington had three bar entrances with least depths as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel, these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta 20 miles up to Wilmington there were several shoals with a least depth of 7.5 feet at low water.

The original projects of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel. Two hundred and three thousand two hundred and four dollars and fifty-nine cents were spent during this time in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrances. At or about this time the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties, under an appropriation for the preservation of fortifications.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet. One hundred and fifty-six thousand two hundred and ninety-six dollars and twenty-six cents was spent during this time upon these works, never fully completed for want of funds.

The project of 1870 proposed a crib closure of the space (4,403 feet long) between Smith's and Zeke's islands (finished in 1873) to prevent further widening of New Inlet. The projects of 1870 to 1872 proposed the complete closure of New Inlet (begun in 1875 and finished in 1881) in order to deepen the water at the main (Baldhead) bar entrance. The projects of 1872 to 1885, as continued to date, proposed the extension of the New Inlet Dam 2 miles further down the stream, to prevent the further erosion of Smith's Island at the Swashes. The project of 1875, as continued to date, proposed the occasional use of dredging

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upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances to obtain first a 12-foot depth at low water and then a 14-foot depth. The projects of 1874 to 1881 for the 20 miles above New Inlet, as continued to date, proposed dredging and occasional diking wherever necessary across shoals, so as to secure first a 12-foot channel 200 feet wide and afterward a 16-foot channel 270 feet wide at low water over this whole length. The total final cost of this work under the projects of 1870 to 1885 was estimated in 1886 at $2,110,000. These estimates have now been increased to $2,120,000. The total amount appropriated therefor up to June 30, 1888, is $1,860,000.

During the fiscal year ending June 30, 1888, $77,055.49, including outstanding liabilites, was spent in opening a continuous channel of at least 185 feet in width and 16 feet in depth at low water from Wilmington to the ocean bar, in placing stone in position upon the dike extending southward from Zeke's Island, in dredging upon the newly-projected bar entrance at Baldhead Channel, in repair and care of plant, in minor surveys of the river, and in office work. These surveys show the recent work to have given very satisfactory results.

Up to June 30, 1888, a total of $1,851,001.74 has been spent in all upon the proposed improvements of 1870 to 1882 with great success, obtaining a 14 to 14.5 feet least depth of water at the main bar entrance and completing a channel of 16 feet depth and at least 185 feet width 28 miles further to Wilmington. This depth, combined with the average rise of tide of 4.5 feet at the bar and 2.5 at Wilmington, is such that at present vessels loaded to 16 feet draught (9.5 feet more than in 1871) can readily go from Wilmington to the ocean in a single tide and any day of the year.

After the improvement is finished its proper maintenance may cost from $5,000 to $15,000 per year for a few years, but the improvement should be fairly permament.

July 1, 1887, amount available		$86,053.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$74,149.56	
July 1, 1888, outstanding liabilities	2,940.33	
July 1, 1888, amount covered by existing contracts	3,045.00	
		80,134.89
July 1, 1888, balance available		5,918.86
Amount appropriated by act of August 11, 1888		245,000.00
Amount available for fiscal year ending June 30, 1889		250,918.86

(See Appendix L 10.)

11. *Waccemaw River, North Carolina and South Carolina.*—When placed under improvement in 1880, this river was navigable for 12-foot-draught boats at all stages of water from Georgetown, Winyaw Bay, 26 miles, to Bull Creek, and at high water 6 miles farther, to Buck's lower mills; thence for 7-foot-draught boats at high water 31 miles further, to Conwayborough; thence it possessed an obstructed channel for 3-foot-draught boats at ordinary low water 109 miles, to Reeve's Ferry, the present head of steam navigation; thence an obstructed channel with 3-foot-depth at high water for 42 miles, to Lake Waccemaw.

The original project of 1880, as continued to date, proposed to secure a channel 12 feet deep at all stages of water, with 80 feet bottom width, from the mouth of the river upward to Conwayborough, and afterwards a cleared channel to Lake Waccemaw. The total final cost of this work

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was estimated, in 1885, at $138,400; the total amount appropriated therefor up to June 30, 1888, $50,400.

During the fiscal year ending June 30, 1888, $4,501.46, including outstanding liabilities, were spent in removing obstructions from 45 miles of river just below Conway, in slight additions to the existing jetties, in minor surveys of the river over its entire length, in caring for property, etc. All work in the field was stopped in September, 1887, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $49,613.54 has been spent in all upon this improvement, giving a thoroughly cleared channel with 100 feet least width, and 8.8 feet least depth at high water as far as Conway, and with 45 feet width and 3 feet depth for 45 miles above Conway.

After this improvement is finished its proper maintenance may cost from $1,000 to $4,000 per year.

July 1, 1887, amount available		$5,287.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,418.00	
July 1, 1888, outstanding liabilities	83.46	
		4,501.46
July 1, 1888, balance available		786.46
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,786.46
Amount (estimated) required for completion of existing project		73,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		18,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 11.)

12. *Yadkin River, North Carolina.*—This river (which is the upper end of the Great Pee Dee River) has a total length of about 200 miles and a drainage area of 4,320 square miles. Its middle third, extending from the railroad bridge near Salisbury, 64½ miles upward, to the foot of Bean Shoal, is the only portion so far under improvement by the General Government.

When placed under improvement in 1880, this portion of the Yadkin River had its navigation completely obstructed by rock ledges, fish and mill dams, and numerous shoals, with a greatest depth of 1 foot at ordinary low water on some of its shoals and ledges.

The original project of 1879 proposes to secure a 2.5 to 3-foot steamboat navigation during the entire year over the 64½ miles above the Salisbury Railroad Bridge. The total final cost of the work necessary to give the desired depth over the entire 64½ miles, and during only mean winter stages of water (two-thirds of the year), was estimated in 1887 at $400,000. The total amount appropriated therefor up to June 30, 1888, is $87,000.

During the fiscal year ending June 30, 1888, $7,692.02, including outstanding liabilities, was spent in removing rock and sand from the channel, in building jetties, in carefully surveying ledges and dams, in caring for the property, and in office work. All work in the field was suspended from November, 1887, to May, 1888, on account of cold and high water.

Up to June 30, 1888, a total of $84,957.92 has been spent in all upon this improvement in securing a good channel for flat-boats (and only an indifferent channel for steam-boats) of 40 to 70 feet channel width and from 2 to 2½ feet channel depth during mean winter stages of water (eight months of the year) from the Salisbury Railroad Bridge, 28 miles upwards, to above Hartley's Mill.

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The improvement, once thoroughly completed, should be comparatively permanent.

July 1, 1887, amount available		$9,734.10
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,924.95	
July 1, 1888, outstanding liabilities	767.07	
		7,692.02
July 1, 1888, balance available		2,042.08
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		12,042.08
Amount (estimated) required for completion of existing project		303,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 12.)

13. *Little Pee Dee River, South Carolina.*—This is a new work. A preliminary examination and survey were made in compliance with the provisions of the river and harbor act approved August 5, 1886, and a report of the results thereof was printed as Appendix M 24 of the Report of the Chief of Engineers for 1887.

The proposed improvement contemplates the removal of logs, trees, and snags from the bed of the river at an estimated cost of $50,000.

The river and harbor act of August 11, 1888, appropriates $5,000 for this work, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act August 11, 1828	$5,000.00
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

14. *Lumber River, North Carolina.*—This is a new work. In obedience to the requirements of the river and harbor act of August 5, 1886, an examination and survey were made of the Lumber River and a report thereon is printed as Appendix M 21 of the Report of the Chief of Engineers for 1887.

The improvement proposed is the removal of snags, logs, and overhanging trees on 98 miles of the river below Lumberton, at an estimated cost of $35,000.

The river and harbor act of August 11, 1888, appropriates $5,000 for this work, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

15. *Clark Creek or River, South Carolina.*—This is a new work. In accordance with the provisions of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Clark Creek, and the reports thereon are printed as Appendix M 23 of the Report of the Chief of Engineers for 1887.

The navigation of Clark Creek is impracticable by reason of overhanging trees, logs, and snags, which obstruct it.

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The estimated cost of removing these obstructions is $7,500.

The river and harbor act of August 11, 1888, makes an appropriation of $2,500 for the work, and a further sum of $5,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$2,500.000
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

16. *Great Pee Dee River, South Carolina.*—When placed under improvement in 1880 this river was dangerously obstructed with snags and logs. Otherwise it was easily reached at a point 37 miles above its mouth by 9-foot draught boats coming from the ocean through the Waccamaw River and Bull Creek; thence it was navigable for the same boats 24 miles further to Smith's Mills, and thence for 3.5-foot draught boats at low water 54 miles further from Smith's Mills to Little Bluff, or at high water 110 miles further, from Smith's Mills to Cheraw, the present head of steam navigation, 171 miles above Georgetown.

The original project of 1880, as continued to date, proposed to secure a thoroughly cleared 9-foot navigation to Smith's Mills and a 3.5-foot navigation to Cheraw at all stages of water. The total final cost of this work was estimated in 1885 at $117,000. The total amount appropriated therefor up to June 30, 1888, is $47,000.

During the fiscal year ending June 30, 1888, $8,673.58, including outstanding liabilities, was spent in removing the worst obstructions over the entire length of the river, in minor surveys along the river, in caring for the property, etc. All work in the field was stopped in May, 1888, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $46,031.69 has been spent in all upon this improvement, giving at all ordinary stages of water a well cleared 9-foot navigation 61 miles upward to Smith's Mills, and a fairly cleared 3.5-foot navigation at low water 50 miles further to the railroad station at Pee Dee, or at high water, 110 miles further, from Smith's Mills to Cheraw.

After the improvement is finished its proper maintenance may cost from $2,000 to $5,000 per year.

July 1, 1887, amount available		$9,641.89
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,562.49	
July 1, 1888, outstanding liabilities	111.09	
		8,673.58
July 1, 1888, balance available		968.31
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		20,968.31
Amount (estimated) required for completion of existing project		50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 13.)

17. *Harbor at Georgetown, South Carolina.*—When placed under improvement in 1880, this harbor had an excellent and well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth.

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A bar of about 2,850 feet in length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown, 13 miles to the ocean.

The original project of 1881, as continued to date, proposed to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through this bar. The total final cost of this work was estimated in 1885 at $39,000. These estimates are now raised to $42,000. The total amount appropriated therefor up to June 30, 1888, is $17,000.

During the fiscal year ending June 30, 1888, $211.60, including outstanding liabilities, was spent in caring for property, in office work, etc. All work in the field was suspended during the entire year because the available funds were not sufficient for advantageous use.

Up to June 30, 1888, a total of $16,834.10 has been spent in all upon this improvement, giving a through cut entirely across the bar, with 12 feet low-water depth, and with a variable width of from 80 to 100 feet.

The channel, once thoroughly opened, will probably be permanent.

July 1, 1887, amount available		$377.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$201.60	
July 1, 1888, outstanding liabilities	10.00	
		211.60
July 1, 1888, balance available		165.90
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		7,665.90

Amount (estimated) required for completion of existing project	17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L 14.)

18. *Mingo Creek or River, South Carolina.*—This is a new work. In obedience to the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the above creek, and the report thereon is printed as Appendix M 22 of the Report of the Chief of Engineers for 1887.

It is estimated that $17,000 will be required to remove the obstructions from this stream.

The river and harbor act of August 11, 1888, appropriates $5,000 for this work, and a further sum of $12,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00

Amount (estimated) required for completion of existing project	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

19. *Winyaw Bay, South Carolina.*—When placed under improvement in 1886 this bay had only 9 feet least depth upon its bar entrance, with a 12-foot channel the rest of the way to Georgetown.

The original project of 1885 proposed to secure a permanent bar entrance from 15 to 20 feet depth at low water. The total final cost of this work was estimated in 1885 at $800,000 for a bar depth at 12 feet (and $2,500,000 for a bar depth of from 15 to 20 feet) at low water. The total amount appropriated therefor up to June 30, 1888, is $18,750.

During the fiscal year ending June 30, 1888, $1,126.30, including out-

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standing liabilities, was spent in surveys and necessary preparations for the principal work of diking, and in the care of property, etc. All work was suspended during the entire year because the available funds were not sufficient for advantageous use.

Up to June 30, 1888, a total of $3,751.72 has been spent upon this improvement in making necessary preparations for beginning work as soon as the available funds shall be sufficient for advantageous use.

The channel, once thoroughly opened, will probably retain its depth permanently.

July 1,1887, amount available		*$16,124.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$990.63	
July 1, 1888, outstanding liabilities	135.67	
July 1, 1888, amount covered by existing contracts	800.00	
		1,926.30
July 1, 1888, balance available		14,198.28
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		114.198.28
Amount (estimated) required for completion of existing project, to be revised by special board		2,381,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L 15.)

20. *Santee River, South Carolina.*—When placed under improvement in 1880 this river had its navigation considerably obstructed and blocked at all stages of water by sunken logs, snags, and floating timber. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet depth of water at low tide, and so situated as to be very difficult and expensive to improve.

The original project of 1880 proposed to provide the river with a good outlet through Mosquito Creek to Winyaw Bay by deepening and straightening this creek to 50 feet width and 7 feet depth; and to secure a safe and unobstructed 7-foot navigation in the river itself from its mouth 154 miles upward to Wright's Bluff, and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers.

The total final cost of this work was estimated, in 1886, at $346,500, of which $271,300 for Mosquito Creek and $75,200 for the Santee River proper.

A modified project of 1881, for the expenditure of the funds then available, as continued to date, proposed to secure to the river a straightened canalized outlet to Winyaw Bay through Mosquito Creek, 7 miles long, 30 feet wide, and 6 feet deep at mean low water, and to construct one draw-bridge over this creek. The total final cost of this work was estimated in 1886 at $144,000, with $5,000 additional for a tide-lock, as required by Congress; in all, $149,000. The total amount appropriated therefor up to June 30, 1888, is $75,750.

During the fiscal year ending June 30, 1888, $522.24, including outstanding liabilities, was spent in draining and diking the ground on the ocean side of the canal, in building a catch-sand fence, in minor surveys along the river, in the care of property, and in office work, etc.

* Erroneously stated on last annual statement as $16,174.58.

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All dredging and other work, though much needed, was suspended during the entire year because the available funds were not sufficient for advantageous use.

Up to June 30, 1888, a total of $70,521.24 has been spent in all upon this improvement, in opening a passage at least 30 feet wide and 5 feet deep at high water from Mosquito Creek to Winyaw Bay, in making necessary surveys of the whole improvement, and in building a draw-bridge over the creek (in accordance with the provisions of the cession of right of way for the canal). The effects of this work upon the rice interests of the neighborhood have been and will be beneficial rather than detrimental.

After this improvement is finished its proper maintenance may cost from $3,000 to $5,000 per year.

July 1, 1887, amount available		$5,751.00
July 7, 1887, amount received from sale to another work		11.24
		5,762.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$516.24	
July 1, 1888, outstanding liabilities	6.00	
		522.24
July 1, 1888, balance available		5,240.00
Amount appropriated by act of August 11, 1888		24,000.00
Amount available for fiscal year ending June 30, 1889		29,240.00
Amount (estimated) required for completion of existing project		47,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		47,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 16.)

21. *Wateree River, South Carolina.*—When placed under improvement in 1882 this river had a low-water depth of from 3 to 4 feet from its mouth in the Santee upward 68 miles to Camden, its practicable limit of steam navigation. From its mouth upward 14 miles the river was complely blocked at all stages of water by sunken logs and stumps and by floating obstructions, and at moderate stages by the bridges of the South Carolina and Wilmington, Columbia and Augusta railroads (without draws); thence 54 miles to Camden navigation was possible, but dangerous, except during high water.

The original project of 1881–'82, as continued to date, proposed to secure a safe and unobstructed 4-foot navigation over this entire distance at all stages of water. The total final cost of this work was estimated in 1885 at $58,000. These estimates are now raised to $60,000. The total amount appropriated therefor up to June 30, 1888, is $35,500.

During the fiscal year ending June 30, 1888, $1,878.88, including outstanding liabilities, was spent in minor surveys along the river, in the care of property, etc. The main work of snagging was suspended during the entire year, partly to await the insertion of draws in the railroad bridges over the river, and partly because the available funds were not sufficient for advantageous use.

Up to June 30, 1888, a total of $34,660.98 has been spent in all upon this improvement, giving a thoroughly cleared 4-foot navigation at all stages of water from the mouth of the river 11 miles upward, and thence a fairly well-cleared 4-foot navigation over the rest of the river, 57 miles, to Camden.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

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July 1, 1887, amount available		$2,717.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,753.66	
July 1, 1888, outstanding liabilities	125.22	
		1,878.88
July 1, 1888, balance available		839.02
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		12,839.02
Amount (estimated) required for completion of existing project		12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

See Appendix L 17.)

22. *Congaree River, South Carolina.*—When placed under improvement in 1886 this river had a low-water depth of from 3 to 4 feet from its mouth 48 miles upward to the railroad bridge at Columbia, and thence a 1-foot low-water depth 2 miles further to its head, the navigation of the lower 47 miles from the mouth upward to Granby being blocked at all stages of water by the South Carolina Railroad Bridge (without a draw), and secondly by sunken logs, snags, overhanging trees, and the navigation of the upper 3 miles above Granby being prevented by its swift current and numerous rock ledges and bowlders.

The original project of 1885 proposed for at least $30,000 to secure thoroughly cleared 4-foot navigation below Granby at all stages of water, and estimated at $24,500 (not recommended for improvement at that time) the cost of a cleared 100-foot channel through the shoals above Granby up to the city of Columbia. The entire work was recommended in 1887, and the total final cost of the work was estimated, as before, at $54,500. The total amount appropriated for this work up to June 30, 1888, is $7,500.

During the fiscal year ending June 30, 1888, $2,038.05, including outstanding liabilities, was spent in all upon this improvement in removing dangerous obstructions from the entire river below Granby, in making minor surveys of the river, and in the care of property, etc. All work of snagging was stopped in October, 1887, because the available funds were no longer sufficient for advantageous use.

Up to June 30, 1888, a total of $6,928.86 has been spent upon this improvement, giving a fairly well-cleared navigation of 70 feet width and 4 feet depth at low water over the entire river below Granby.

After this improvement is finished its proper maintenance may cost from $1,000 to $2,000 per year.

July 1, 1887, amount available		$2,609.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	22,004.38	
July 1, 1888, outstanding liabilities	33.67	
		2,038.05
July 1, 1888, balance available		571.14
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		8,071.14
Amount (estimated) required for completion of existing project		39,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix L 18.)

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EXAMINATIONS TO COMPLY WITH THE REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

The following localities were, after examination, reported by the local engineer as not at this time worthy of improvement:

1. *Yadkin River from South Carolina line to the Narrows, North Carolina.*—Report printed in House Ex. Doc. No. 58, Fiftieth Congress, first session. (See, also, Appendix L 19.)

2. *Catawba River, North Carolina.*—Report printed in House Ex. Doc. No. 58, Fiftieth Congress, first session. (See, also, Appendix L 20.)

IMPROVEMENT OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA.

Officers in charge, Col. Q. A. Gillmore, Corps of Engineers, to April 6, 1888; Col. Henry L. Abbot, Corps of Engineers, from April 6 to April 20, 1888; since which date Lieut. F. V. Abbot, Corps of Engineers, with Col. William P. Craighill, Corps of Engineers, Supervising Engineer.

1. *Charleston Harbor, South Carolina.*—The work of improvement in progress since 1878 comprises two jetties, composed of riprap stone resting upon a foundation mattress of logs and brush, with a mattress hearting wherever deemed advantageous.

The two jetties spring, respectively, from Sullivan's and Morris islands, and converge on curves in such manner as to cros the bar on parallel lines at a distance of about 2,900 feet from each other. The object of the work is to establish and maintain an improved channel across the bar of not less than 21 feet navigable depth at mean low water, where heretofore the available low-water depth has usually not exceeded 11½ feet.

The estimated cost of the project is $3,000,000. A revision of this project and estimate has been ordered before further work is done.

The following work is reported to have been done during the past fiscal year:

North Jetty.—This jetty has been re-inforced during the year by the deposit of 7,613 cubic yards of riprap distributed over the middle 36 feet, between points 8,400 feet and 12,184 feet from the shore end.

South Jetty.—Where the jetty crosses the deep pocket, east of the main ship-channel, it was raised for a length of 434 feet by depositing along the middle 30 feet about 2,282 cubic yards of riprap stone. For a length of 1,293 feet, beginning at a point about 14,207 feet from the shore end, about 3,232 cubic yards of stone were distributed over the middle 36 feet of the jetty, for the purpose of strengthening and preserving the work already done, which is here almost up to low water and much exposed to breakers.

The expenditures from the beginning of operations under the existing project to June 30, 1887, were $1,399,346.49. During the last fiscal year the sum of $64,686.50, including outstanding liabilities, was expended.

No extension of the jetties seaward was made during the year. Measured along their axes, the outer end of the bottom course of the north jetty is located 14,327 feet from its shore end on Sullivan's Island; that of the south jetty, 16,440 feet from the present shore end on Morris Island.

No material changes in the condition of the jetties are reported. The damaged shore end of the south jetty, between the high and low

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water lines of the beach of Morris Island, has been repaired. The head of Morris Island has cut away rapidly. This action has continued along the whole length surveyed, but is not over 70 feet at the jetty, and 30 feet a quarter of a mile south of it. On Sullivan's Island no marked changes have occurred.

The engineer officer in charge reports indications of considerable activity of ebb scour between the outer parts of the jetties.

The two spur-jetties built in 1884 for the protection of a portion of the shore of Mount Pleasant are stated to be in good condition.

It is intended to retain the balance on hand on July 1, 1888, in case repairs are needed.

The appropriations for this improvement aggregate at present $1,482,500. The total expenditures have been $1,464,032.99, including outstanding liabilities.

July 1, 1887, amount available		$83,153.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$64,376.25	
July 1, 1888, outstanding liabilities	310.25	
		64,686.50
July 1, 1888, balance available		18,467.01
Amount appropriated by act of August 11, 1888		350,000.00
Amount available for fiscal year ending June 30, 1889		368,467.01
Amount (estimated) required for completion of existing project (to be revised)		1,175,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890.		750,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix M 1.)

2. *Wappoo Cut, South Carolina.*—Wappoo Cut is a narrow, crooked tidal stream, separating James Island from the mainland and connecting Stono and Ashley rivers.

The project of improvement contemplates the establishment of a straighter channel, 6 feet deep and 90 feet wide at low water, at an estimated cost of $34,000. In its unimproved condition only 2 to 4 feet could be carried over the principal shoals at mean low water.

The plan of improvement comprised dredging at the entrances from Ashley and Stono rivers and through a portion of the cut; a cut-off through the marsh about 2½ miles from Ashley River, closing three small tidal branches; and the construction of a short jetty at both the Stono and Ashley rivers.

Four appropriations aggregating $28,000 have thus far been made for this improvement, of which the last, amounting to $5,000, was made by act approved August 5, 1886.

The first three appropriations were expended in improving Elliott's Cut and bar at its Stono mouth, in making a solid cut through the marsh of the neck of the bend known as Devil's Elbow, and in deepening the tortuous channel between these places. Some dredging was done on the bar at the entrance from Ashley River. A dam was built across the tidal branch named Pompey's Cut, and a number of snags and overhanging trees were removed. The total expenditures to June 30, 1887, were $22,999.63.

The work which has been done, mostly in the shallow westerly portion of Wappoo Cut, has resulted in a considerable increase of its navigable depth. The full width contemplated has not yet been obtained.

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The total amount expended to June 30, 1888, is $27,796.42.

July 1, 1887, amount available	$5,000.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,796.79
July 1, 1888, balance available	203.58
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,203.58
Amount (estimated) required for completion of revised project	60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	35,000.00

(See Appendix M 2.)

3. *Ashley River, South Carolina.*—Ashley River is about 40 miles in length and runs in a generally southeasterly direction. At its mouth the city of Charleston occupies the left bank.

The plan of improvement comprised (1) the removal of a shoal at a place named Accabee, about 8 miles above the city of Charleston, where, according to a survey made in 1873, there was then only 9 feet of water at low tide; and (2) the removal of a shoal just below the Wando Phosphate Works, where only 6 feet of water was found at low tide. It was proposed to increase the draught of water over these shoals by dredging to a depth of from 10 to 11 feet at mean low tide, at an estimated cost of $5,000.

Of four appropriations made for this work, the first three, aggregating $4,500, were expended in improving the river at the places indicated, obtaining low-water depths of from 10 to 11 feet on widths of from 100 to over 200 feet. This satisfactory condition of the river has continued during the past fiscal year, for which reason the last appropriation of $1,000, made by act approved August 5, 1886, was held in reserve until it should appear expedient or necessary to expend it.

The total amount expended to June 30, 1888, was $4,494.91.

July 1, 1887, amount available		$1,031.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26.17	
July 1, 1888, outstanding liabilities	.28	
		26.45
July 1, 1888, balance available		1,005.09

(See Appendix M 3.)

4. *Edisto River, South Carolina.*—The Edisto is one of the principal rivers of South Carolina. It is formed by the junction of the North and South Forks, which unite in the southern part of Orangeburgh County. The South Fork, commonly known as the South Edisto, is the main river.

The obstructions to navigation consist of numerous bends, logs, snags, overhanging trees, and piles; also of shoals, generally of sand, but in some places of hard clay.

The plan of improvement contemplates the establishment of a channel available at all seasons of the year for the navigation of light-draught steam-boats from the sea to the junction of the North and South Forks, a distance of 183 miles, and from that point to Guignard's Landing, 77 miles higher up, for rafts and flat-boats. The plan embraces enlarging all the new channels now in progress of formation, cutting off bends, shutting off lateral arms of the river, removing shoals, snags, logs, piles, and other obstructions, and building a deflecting jetty. The cost of the project was estimated at $33,385.

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Three appropriations made by Congress in the years 1882, 1884, and 1886, respectively, and aggregating $16,000, were expended previous to July 1, 1887.

The work heretofore done comprised the removal of a large number of snags, logs, overhanging trees, and piles in the reaches within 130 miles of the mouth of the river; the improvement of a natural cut-off known as the "Suck" 50 miles above Jacksonborough, to make it the regular channel; the closing of incipient cut-offs and outlets, and trimming the banks. These operations cost the sum of $15,830.85. They materially benefited navigation by shortening the time and reducing the expense of trips.

The total expenditures up to June 30, 1888, were $15,854.85.

July 1, 1887, amount available	$169.15
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24.00
July 1, 1888, balance available	145.15
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,145.15
Amount (estimated) required for completion of existing project	12,385.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 4.)

5. *Salkiehatchie River, South Carolina.*—The Salkiehatchie rises in Aiken County, South Carolina, and flows into the Atlantic Ocean. The lower part of the river is known as the Combahee. Above a point named Hickory Hill, about 44 miles from the coast, the river was obstructed at numerous places by piles, logs, trees, and sand-bars.

The project of improvement contemplates the removal of these obstructions for the purpose of establishing a continuous channel suitable for flat-boats and rafts from a point 5 miles above Toby's Bluff down to Hickory Hill, a distance of about 77 miles by river. The cost of the project was estimated at $18,000.

Prior to July 1, 1887, three appropriations, made in the years 1882, 1884, and 1886, respectively, and aggregating $10,000, were expended in this improvement.

The work done by means of the first appropriations consisted in thoroughly clearing the lowest 12-mile reach of the Salkiehatchie between Hickory Hill and the Charleston and Savannah Railroad Bridge and improving the reaches, aggregating 80 miles in length, from that bridge to Broxton's Fork by removing from the channel over 11,800 snags, stumps, logs, trees, etc., closing over 129 outlets, cutting off numerous projecting points, and other miscellaneous work. One dam was built.

The sum of $9,638.66 was expended in these operations. Lack of funds has prevented any work in the past year.

A substantial improvement of the river is reported.

The total expenditure to June 30, 1888, was $9,662.66, including outstanding liabilities.

July 1, 1887, amount available	$361.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24.00
July 1, 1888, balance available	337.34
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,337.34

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Amount (estimated) required for completion of existing project	$5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M 5.)

6. *Removing sunken vessels or craft obstructing or endangering navigation.*—During the past fiscal year the wreck of a trading boat was removed from the Chehaw River, South Carolina, and the wreck of the steamer *Alice Clark* was taken from the inside passage between Charleston, S. C., and Savannah, Ga., and sold at public auction; authority, section 4, act of June 14, 1880.

(See Appendix M 6.)

EXAMINATION TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF JULY 5, 1884.

Under the river and harbor act of July 5, 1884, Colonel Gillmore was also charged with the preliminary examination of the *North Fork of the Edisto River in the counties of Orangeburgh and Lexington, South Carolina.* His report on this examination is submitted herewith. (See Appendix M. 7.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the locality was worthy of improvement, Colonel Gillmore was charged with and completed the survey of *Mosquito Creek between the South Edisto and Ashepoo rivers, with a view to connect the South Edisto with the Ashepoo at or near Fenwick's Island, South Carolina*, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 117, Fiftieth Congress, first session. (See also Appendix M 8.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, AND OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

Officers in charge, Col. Q. A. Gillmore, Corps of Engineers, to April 6, 1888; Col. Henry L. Abbot, Corps of Engineers, from April 6, to April 24, 1888, since which date Lieut. O. M. Carter, Corps of Engineers, with Col. Wm. P. Craighill, Corps of Engineers, Supervising Engineer,

1. *Savannah River and Harbor, Georgia.*—The plan according to which operations have up to the present time been carried on in the Savannah Harbor and River was adopted in 1873, and modified and enlarged in 1879 and again in 1882. It contemplated the establishment of a channel from Tybee Roads to the city of Savannah, navigable at high water for vessels of 22 feet draught, and the widening of the river opposite the city to 600 feet, of uniform depth with the balance of the channel. The cost was originally estimated at $482,000, and as amended and enlarged at $1,212,000.

In 1887, in obedience to an act of Congress, plans were submitted for obtaining a high-water channel 28 feet deep from the city of Savannah to the sea.

The cost was estimated at $6,660,000.

In 1873, prior to improvement, the channel was, in places, not more than 9 feet deep at mean low water, and the usual high-water draught of vessels was not more than 14.5 feet.

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During the fiscal year just closed 817.93 cubic yards of brush fascines and 429.23 cubic yards of riprap stone were employed in the work. Operations were suspended on July 3, 1887, on account of lack of funds.

The expenditures during the year amounted to $3,227.54.

The total amount expended to June 30, 1888, including all outstanding liabilities, is $1,031,581.35, and has resulted in securing a navigable channel from the city to the sea with a least mean low-water depth of 12.4 feet, a gain of 3.4 feet since the work was begun. The gain in navigable depth is somewhat greater than here shown, and vessels of from 20 to 21 feet draught now go from the city to the sea on a single tide.

The estimated reduction in freight rates, due to the improvements already executed, is 25 per cent., which effects an annual saving in freights alone of more than the total sum of money expended by the United States upon the harbor within the last twenty-five years. There is no reason to believe that future expenditures for this work would yield a less valuable return. The sum necessary to complete the improvement according to the plans for obtaining 28 feet of water from the city to the sea is estimated at $6,660,000.

July 1, 1887, amount available		$3,646.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,545.23	
July 1, 1888, outstanding liabilities	680.31	
		3,225.54
July 1, 1888, balance available		420.65
Amount appropriated by act of August 11, 1888		180,000.00
Amount available for fiscal year ending June 30, 1889		180,420.65
Amount that can be profitably expended in fiscal year ending June 30, 1890, in maintaining existing works		50,000.00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

(See Appendix N 1.)

2. *Savannah River, Georgia.*—The present project for the improvement of this river was adopted in 1880, the object being to secure a low-water steam-boat channel not less than 5 feet in depth between the cities of Augusta and Savannah, Ga.

The cost of the improvement was originally estimated at $91,000, and in 1887, for reasons given in the Annual Report of that year, at $176,000. Prior to the improvement navigation was much impeded by logs, snags, piles, and other obstructions. The depth at summer low water over some of the shoals did not exceed 2 or 3 feet.

No work was done during the last fiscal year on account of lack of funds. The total amount expended to June 30, 1888, including all outstanding liabilities, is $72,349.77, and has resulted in improving the condition of the shoals near Augusta, and in removing the most dangerous obstruction to navigation throughout the whole extent of the river, no accidents to steam-boats having occurred since these obstructions were removed.

The amount necessary to complete the improvement can not be estimated in advance of an examination, to be made as soon as funds are available and the stage of the river will permit, the amounts given in previous reports upon this work as necessary to complete the improvement being, for reasons given in the report of the engineer in charge, too small.

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July 1, 1887, amount available		$154.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3.19	
July 1, 1888, outstanding liabilities	1.50	
		4.69
July 1, 1888, balance available		150.23
Amount appropriated by act of August 11, 1888		21,000.00
Amount available for fiscal year ending June 30, 1889		21,150.23
Amount (estimated) required for completion of existing project		85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix N 2.)

3. *Savannah River above Augusta, Georgia.*—The project for the improvement of this river was adopted in 1879, the object being to secure a low-water pole-boat channel, 30 feet in width and 3 feet in depth, between Augusta and Trotter's Shoal, 64 miles above. The cost of the improvement, which was not based upon accurate surveys, was estimated at $45,000.

The obstructions to navigation consisted chiefly of rock ledges running across the channel, bowlders of various sizes, and shoals of gravel, with depths at low-water stage of from 1 to 2 feet.

No work has been done upon this river since August, 1883.

The total amount expended to June 30, 1888, including all outstanding liabilities, is $38,296.98, and has resulted in improving the medium-stage channel through a few of the rock ledges, and in removing some of the most dangerous bowlders obstructing navigation. No additional commerce has been developed upon the stream by the work done, nor have freight rates been appreciably reduced by that cause, although no accidents to pole-boats have occurred since the work of improvement was done.

July 1, 1887, amount available	$822.71
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	119.69
July 1, 1888, balance available	703.02

(See Appendix N 3.)

4. *Romley Marsh, Georgia.*—The project for the improvement of this locality was adopted in 1880, the object being to open a cut, with a minimum bottom width of 48 feet and a mean low-water depth of 7 feet, between Dead Man's Hammock Creek on the north and Wassaw Creek on the south. The cost was estimated at $38,720.

The natural channel is extremely crooked and difficult to navigate, and at the shoalest part not more than than 3.5 feet deep at mean low water. No work was done during the last fiscal year.

The total amount expended to June 30, 1888, including all outstanding liabilities, is $46,887.22, including $9,633.77, advanced by private parties, and has resulted in the completion of the work, securing a navigable channel between Wassaw and Ossabaw Sounds with a low-water depth of not less than 4.2 feet. The cut is not located in the most suitaable place, either for maintenance or for the convenience of shipping.

No appropriation is asked for the next fiscal year.

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July 1, 1887, amount available	$396.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	174.65
July 1, 1888, balance available	221.65
Amount appropriated by act of August 11, 1888	4,633.77
Amount available for fiscal year ending June 30, 1889	4,855.32

(See Appendix N 4.)

5. *Altamaha River, Georgia.*—The present project for the improvement of this river was adopted in 1880, the object being to secure a steam-boat channel 80 feet in width and 3 feet in depth at low-water stage between Darien, Ga., and the junction of the Oconee and Ocmulgee Rivers. The cost of improvement was originally estimated at $60,000, and in 1884 at $75,000.

Prior to improvement navigation was much impeded by logs, snags, and other obstructions, the low-water depth at some points not exceeding 2 feet.

During the fiscal year just closed 424 snags and 998 other obstructions, such as logs, stumps, overhanging trees, etc., were removed. The expenditures amounted to $7,109.11.

The total amount expended to June 30, 1888, including all outstanding liabilities, is $45,071.03, and has resulted in removing the most dangerous obstructions, no interruption to steam-boat navigation having occurred during the year.

July 1, 1887, amount available	$7,038.08
Amount transferred from Doboy Bar	4,204.60
	11,242.68
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,109.11
July 1, 1888, balance available	4,133.57
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	14,133.57
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 5.)

6. *Doboy Bar, Georgia.*—The project for the improvement of this bar was adopted in 1886. It provides for the experimental expenditure of a small sum of money with the object of deepening the bar by propeller sluicing or hydraulic excavating.

The natural channel is crooked, with minimum low-water depths of not more than 11.1 feet.

The total amount expended to June 30, 1888, including all outstanding liabilities, is $5,795.40, which was applied to carrying on the work of scraping and hydraulic excavating during the last fiscal year, with no permanent useful result.

The commercial importance of the locality does not now seem to justify permanent improvement, and there is no reason to expect satisfactory results from the expenditure of small sums of money in temporary improvement.

July 1, 1887, amount available		$10,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,795.40	
Transferred to Altamaha River	4,204.60	
		10,000.00

(See Appendix N 6.)

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7. *Brunswick Harbor, Georgia.*—The present project for the improvement of this harbor was adopted in 1880, and modified and enlarged in 1886, the object being to secure a navigable channel not less than 15 feet deep at mean low water. The mean rise and fall of tide is 6.8 feet. The cost of the project of 1880 was estimated at $73,187.50 and as enlarged in 1886 at $190,000, inclusive of appropriations already made.

In 1880, prior to improvement, the channel was not more than 9 feet deep at mean low water.

No work was done during the fiscal year just closed on account of lack of funds.

The amount expended to June 30, 1880, including all outstanding liabilities, is $92,463.27, and has resulted in securing a navigable low-water channel not less than 11.5 feet deep.

July 1, 1887, amount available		$88.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1.84	
July 1, 1888, outstanding liabilities	49.87	
		51.71
July 1, 1888, balance available		36.73
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		35,036.73
Amount (estimated) required for completion of existing project		62,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		62,500.00

(See Appendix N 7.)

8. *Jekyl Creek, Georgia.*—This is a new work. In compliance with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Jekyl Creek, and the report thereon was transmitted to Congress January 20, 1888, and printed in House Ex. Doc. No. 117, Fiftieth Congress, first session.

The project for improvement is to obtain at the shallow reaches an improved low-water depth of 7 feet, by the construction of training-walls and dredging, at an estimated cost of $38,500.

The river and harbor act of August 11, 1888, appropriates $5,000 for the work, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	33,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

9. *Cumberland Sound, Georgia and Florida.*—The present project for the improvement of the entrance to this sound was adopted in 1879, the object being to secure a navigable low-water channel across the bar from 20 to 21 feet in depth. The cost of improvement was estimated at $2,071,023.

Prior to improvement the low-water depths of the entrance varied from 11 to 12.5 feet, with a mean rise and fall of tide of 5.9 feet.

During the fiscal year just closed the second course of the south jetty was advanced seaward 3,505 1 feet. Operations were suspended on account of the exhaustion of funds on November 26, 1887. During the

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year an accurate triangulation of the harbor was made for use in future surveys.

The expenditures amounted to $59,711.62. The total amount expended to June 30, 1888, including all outstanding liabilities, is $366,494.26.

It is proposed during the coming year, with any funds which may become available, to raise and perhaps extend the south jetty.

The amount estimated as necessary to complete the improvement is $1,591,000.

July 1, 1887, amount available	$60,717.36
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	59,711.62
July 1, 1888, balance available	1,005.74
Amount appropriated by act of August 11, 1888	112,500.00
Amount available for fiscal year ending June 30, 1889	113,505.74
Amount (estimated) required for completion of existing project	1,591,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N 8.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Colonel Gillmore was charged with and completed the following surveys, the results of which were transmitted to Congress and printed as Executive Documents of the Fiftieth Congress, first session:

1. *Savannah River from Cross Tides, above Savannah, to the Bar, with a view to obtaining 28 feet of water in the channel.*—Printed in House Ex. Doc. No. 57. (See also Appendix N 9.)

2. *Jekyl Creek, Georgia.*—Printed in House Ex. Doc. No. 117. (See also Appendix N 10.)

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN THE STATE OF FLORIDA.

Officer in charge, Capt. William M. Black, Corps of Engineers, with Lieut. D. DuB. Gaillard, Corps of Engineers, under his immediate orders. Supervising Engineer, Col. William P. Craighill, Corps of Engineers.

1. *St. John's River, Florida.*—Operations for the improvement of this river have been carried on in conformity with a plan submitted by the late General Gillmore, Corps of Engineers, in 1879. This plan contemplates the formation of a continuous 15-foot channel in the St. John's River, between Jacksonville and the ocean. The project was in two parts: 1, the formation of a channel across the bar at the mouth by the contraction produced by two jetties starting from opposite sides of the river at its mouth, and so directed that the outer ends on the bar shall be approximately parallel and 1,600 feet apart; 2, the improvement of some defective reaches in the river near Dame's Point. The estimated cost of the two parts of the project were $1,306,500 and $120,000, re-

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spectively. All work up to the present time has been done on the first portion of the project, under five appropriations aggregating $675,000, and made for improving "the channel over the bar at the mouth."

Before improvement, the channel over the bar had an available mean low-water depth varying from 5 to 7 feet, and shifted north and south through an area a mile in length.

On June 30, 1887, the south jetty had a total length of 6,667 feet, of which 2,650 feet were built to the level of mean low-water. The north jetty had a total length of 5,603 feet, of which 3,000 feet had its crest at the level of mean low water. Neither jetty was built with a full sized cross-section. Both are composed of one or more layers of log and brush mattresses covered with riprap stone. The effects of the work were to form a straight channel across the bar, which had a least mean low-water depth of 9.8 feet.

Operations during the fiscal year ending June 30, 1888, were continued under the remainder of the appropriation made in act approved August 5, 1886. The greater part of the work was done under contract. Work by hired labor was confined to a small amount of experimental concrete work, and to operations for connecting the north jetty with the light shifting sand beach, which, from their nature, could not have been done advantageously by contract. The old sailing gap of the south jetty was closed, the foundation of the north jetty was extended 909 feet, and its superstructure built to the level of mean low water, with a crest 12 feet wide and side slopes of 1 on 1, for a distance of 1,800 feet; the shore extension was strengthened and made stable with side and wing walls of riprap, and the jetty was raised to full height and capped with concrete for a distance of 148 feet. Work on the jetties was suspended (excepting the experimental concrete work) early in February, 1888, for lack of funds. All work was suspended in April and the plant stored.

The south jetty is now 6,667 feet long, and its crest for 4,100 feet from the shore end is at the level of mean low water, and for the remaining distance at an average mean low-water depth of 6 feet. The north jetty is 6,585 feet long. Its crest is at full height for 553 feet, at mean low-water level for 5,079 feet, and at a depth varying from 0 to 10 feet for the remaining distance.

The channel across the bar has steadily improved during the year. At the date of the last survey in May, the least depth on the bar was over 13 feet. On account of the divergence of an increased portion of the ebb flow from the river through the false channel along the north jetty, the shoaling on the jetty middle ground has continued and the channel depth there is now less than that on the bar. The completion of the jetty work will remove this shoal, but if this work is too long delayed this obstruction may become serious.

Of the three reaches between Jacksonville and the ocean, where the channel depth is less than 15 feet on the bar, the jetty middle ground, and that near Dame's Point, the last is now the most obstructive to navigation. Its depth (9 to 10 feet) now controls the lading of vessels entering the St. John's, and its improvement is earnestly desired, in order to gain the full benefits of the successful work at the bar. It is recommended that future appropriations be made for the entire project "for improving St. John's River, between Jacksonville and the ocean," under the aggregate estimate. It is thought the jetty work can be completed with the amount of the original estimate yet unappropriated, viz, $631,500. The aggregate estimate for the completion of the project will then be $751,500.

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July 1, 1887, amount available		$111,741.77
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$107,252.57	
July 1, 1888, outstanding liabilities	446.33	
		107,698.90
July 1, 1888, balance available		4,042.87
Amount appropriated by act of August 11, 1888		175,000.00
Amount available for fiscal year ending June 30, 1889		179,042.87
Amount (estimated) required for completion of existing project		576,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 1.)

2. *Volusia Bar, Florida.*—Volusia Bar is situated at the head of Lake George and is formed by materials brought down by the St. John's River, and deposited at the point where the current of the narrow river loses its velocity, as the bed widens to form the lake. The usual depth on the bar, before operations began, was from 3½ to 4 feet. At times this depth was diminished so much as to stop navigation entirely.

The adopted plan of improvement was to contract the waters on the bar by the construction of two converging brush and stone jetties, with a view to causing a scour to the depth of 6 feet. Should the depth caused by the jetties not be sufficient, recourse was to be had to dredging. Between the jetties on the bar, lines of guide-piles were placed to keep vessels off the jetties and to define the channel clearly.

In 1887 it was decided to limit the channel depth sought to the 5 feet then obtained, on account of the evident shoaling in the lake beyond the jetties and because that depth was sufficient for the requirements of the existing river commerce.

Up to June 30, 1887, $24,287.43 had been expended, including liabilities then outstanding. The jetties had been built to their full length and to a height sufficient to produce the desired effect; two lines of firmly-set fender-piles defined the jetty channel on the crest of the bar; and a straight channel with a minimun mean low-water depth of 5 feet had been obtained. During the fiscal year ending June 30, 1888, operations were limited to the necessary examinations. At the last examination, made in April, 1888, the work was found in good condition and the channel depth had been maintained.

July 1, 1887, amount available		$712.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		359.01
July 1, 1888, balance available		353.56
Amount appropriated by act of August 11, 1888		500.00
Amount available for fiscal year ending June 30, 1889		853.56
Amount that can be profitably expended in fiscal year ending June 30, 1890, for repairs		500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 2.)

3. *Harbor at Saint Augustine, Florida.*—This is a new work. In compliance with the requirements of the river and harbor act of August 5, 1886, an examination and survey were made of "Saint Augustine for a deep-sea channel on the outer bar, Florida," and the report of the

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results thereof was transmitted to Congress January 11, 1888, and printed in House Ex. Doc. No. 87, Fiftieth Congress, first session.

The project proposed for the improvement of the entrance is to concentrate the flow over the bar, and thus increase the scour by the construction of solid converging jetties, etc., at an estimated cost of $1,467,888.

The river and harbor act of August 11, 1888, appropriates $35,000 for improving the harbor, but directs that the subject be referred to a Board of Engineers, whose report is to be laid before Congress at its next session. No estimate for the next fiscal year can be submitted until the report of this Board is received, when it will be transmitted to Congress.

4. *Northwest entrance, Key West Harbor, Florida.*—A bar having a channel depth of 10.5 feet obstructs the northern entrance to this harbor. During storms the available depth is so much reduced, that vessels bound to and from Gulf ports can not use it, but are compelled to make a détour of about a hundred miles by Dry Tortugas to enter or leave the Gulf.

An examination of the entrance with a view to its improvement was made in 1867 and again in 1881. In 1882 Congress made an appropriation of $25,000 for dredging a channel 300 feet wide and 17 feet deep deep across the bar.

The work was done in 1883. Before commencing it the officer in charge expressed an opinion that the work would not be permanent. In 1884 the channel had filled.

In act approved August 5, 1886, $2,500 were appropriated for a new examination and survey of the bar. This was made in December, 1886, and January, 1887. The bar was found to be formed and maintained by interfering tidal currents.

No funds were available for operations during the past fiscal year.

Amount appropriated by act of August 11, 1888	$25,000.00
Amount (estimated) required for completion of existing project, subject to revision	583,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 4.)

5. *Caloosahatchee River, Florida.*—Before improvement, the lower part of the river was so obstructed by oyster-bars that the available channel depth was only 5½ feet. About 17 miles above the mouth the river loses the characteristics of an estuary, and there are numerous islands and a broad shoal.

The project adopted in 1882 called for the formation, by dredging, of a channel 100 feet wide and 7 feet deep from the bay to Fort Meyers, a distance of 14 miles. In 1886 this project was modified, so as to include the improvement of the upper river as far as Fort Thompson, by removal of snags and overhanging trees.

Up to the close of the fiscal year ending June 30, 1887, $13,044.72 had been expended under these projects. A channel of the required width, and having a least depth of 6 feet, had been formed below Fort Meyers, and one of the worst reaches of the river, extending 4½ miles above Fort Denaud, had been cleared of snags and overhanging trees. During the past fiscal year, owing to the small sum available, it was not possible to resume the snagging operations, which had been stopped by high water in June, 1887. Work was therefore confined to plotting the notes

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of a survey made in the previous fiscal year, and in preparing maps of the river.

July 1, 1887, amount available		$955.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$691.53	
July 1, 1888, outstanding liabilities	73.67	
		765.20
July 1, 1888, balance available		190.08
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,190.08

(See Appendix O 5.)

6. *Pease River, Florida.*—This river rises about the center of Polk County, Florida, and flows southwest into Charlotte Harbor. For the last 12 miles of its course it has the caracteristics of an estuary. The rest of the stream flows through a heavily-wooded and sparsely-populated country, and is much obstructed by fallen trees, snags, rocks, and bars. It is subject to great changes of level. During the low-water season not more than 14 inches to 24 inches of water can be relied on.

The project for its improvement, adopted in 1881, is to improve it for high-water navigation by the removal from the channel of snags, overhanging trees, and loose rocks between Fort Meade and the mouth, a distance, by river, of about 100 miles. Since the project was adopted the Florida Southern Railroad has been opened along the river.

The amount expended up to June 30, 1887, was $12,016.74. The river was cleared for a distance of 64 miles.

In the act approved August 5, 1886, $13,000 was appropriated for improving Manatee and Pease rivers, of which $5,000 could be expended on Pease River.

As no practical benefit could be derived from expending so small a sum on the improvement of this river, it was decided to reserve $2,000 with which to make a survey on which a project could be founded, and to expend the remainder in improving Manatee River.

The field work of the survey has been completed and plotted.

July 1, 1887, amount available	$983.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	780.73
July 1, 1888, balance available	202.53
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	25,000.00

(See Appendix O 6.)

7. *Manatee River, Florida.*—The portion of the Manatee River under improvement is the last reach between Rocky Bluff and the mouth, a distance of about 12 miles. This has a mid-channel depth of from 7 to 20 feet. The general width is about three-fourths of a mile. At the mouth is a long shoal with a minimum depth of 8½ feet. Between Palmetto and Manatee, about 6 miles from the mouth, is another bar covered by from 3 to 5 feet of water.

The river was examined in 1881. An appropriation of $12,000 for its improvement was made in 1882. The project adopted had for its object to form a channel 100 feet wide and 13 feet deep at mean low water from Tampa Bay to McNeill's Point (Palma Sola). The appropriation was expended in 1883–84, and a cut 2,150 feet long was made, varying in width from 35 to 60 feet, and having a depth of 12½ feet.

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In act approved August 5, 1886, $13,000 were appropriated for improving Manatee and Pease rivers, of which $11,000 were allotted to work on Manatee River.

Owing to the changed commercial conditions since the adoption of the project, brought about by the extension of the railroad to Tampa, the transfer to Tampa of the principal Gulf steam-ship lines, and the service of the smaller towns around Tampa Bay by coasting steamers from Tampa, the project was modified, to provide for the passage of these lighter-draught vessels to all of the towns of the lower river by the removal of the bar above Palmetto.

A survey of this bar was made, and operations for its removal by dredging were commenced on August 22, and finished on September 27, 1887. Fifteen thousand three hundred and two and three-tenths cubic yards of soft material were removed, giving a cut 2,412 feet long, 65 feet wide, and 8 feet deep. A survey made in January, 1888, shows that the dredged cut had shoaled at its extreme ends, but had maintained its depth at other places.

In accordance with the project for a survey of the Manatee River, Florida, approved December 22, 1886, a survey of the river was made in December, 1887, and January, 1888, and maps of the river were plotted.

July 1, 1887, amount available	$10,390.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,774.61
July 1, 1888, balance available	615.87
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,615.87
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,000.00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 7.)

8. *Tampa Bay, Florida.*—The harbor at Tampa, at the head of this bay, was separated from deep water by a flat 2 miles wide. Through this was a narrow channel with an average available depth of about 5 feet, formed by the waters of Hillsborough River.

The present project was adopted in 1880, and has for its object the formation of a 9-foot channel from the 9-foot curve in the bay to the wharves at Tampa, in Hillsborough River, 150 feet wide in the bay and 200 feet wide in the river, at an estimated cost of $97,000.

Up to June 30, 1887, $59,941.17 had been expended.

The work consisted entirely of dredging and rock excavation, and extended over a length of 8,215 feet, with a width varying from 60 feet in the bay to 150 feet in the river. This channel has been filled somewhat by the tidal currents, and on June 30, 1887, it had a depth along the center line of from 8.3 to 9 feet, with a width of about 60 feet.

In the act approved August 5, 1886, $10,000 were appropriated for this work. Under this appropriation operations were commenced on June 29, 1887, and completed on August 12, 1887, giving a clear channel, 9 feet deep, at the bend at the mouth of Hillsborough River, varying in width from 200 feet in the river to 50 feet in the bay.

In the annual report for 1886 it was estimated that $73,000 would be required to complete the project.

During the past year a point in the deep water of this bay, Porto Tampa, has been connected with Tampa by the extension of the South

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Florida Railway, and has become the terminus of the Key West and Havana line of steamers. Fifteen feet of water can now be carried to Porto Tampa. At an estimated cost of $63,000 for dredging, 20 feet of water can be carried from the Gulf of Mexico to this point. The total estimated cost of the modified project is $88,000.

Existing project is for a channel 200 feet width, of 20 feet depth from the outer bar to Mangrove or Bushy Point, which is estimated to cost $50,000.

July 1, 1887, amount available		$9,632.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,603.22	
July 1, 1888, outstanding liabilities	97.50	
		8,700.72
July 1, 1888, balance available		931.46
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,931.46
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 8.)

9. *Withlacoochee River, Florida.*—The river was examined with a view to its improvement in 1879. The adopted project calls for the removal of snags, overhanging trees, and loose rocks, and some of the worst shoals between the Gulf and Pemberton Ferry, a distance of about 100 miles, so as to permit boats of 2 feet draught to navigate the river during half the year.

The normal width of the river varies from 75 to 150 feet, though in many places its bed widens in a cypress swamp or grass marsh, through which a sluggish current passes in narrow winding lagoons. At other places the river is obstructed by loose rocks. The depth varies from 1 foot to 7½ feet.

Three appropriations have been made for the improvement of this stream, aggregating $13,000, and, excepting at three points, navigation has been opened according to the project. Owing to a lack of funds no work was done during the last fiscal year beyond caring for the public property.

July 1, 1887, amount available	$138.77
July 1, 1888, balance available	138.77
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,138.77
Amount (estimated) required for completion of existing project	5,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 9.)

10. *Harbor at Cedar Keys, Florida.*—The improvement of this harbor has been carried on from time to time under various appropriations made since 1872. It was obstructed by a shoal locally called the Bulkhead or Middle Ground, lying between Way Key and the main ship-channel; at several points in the main ship-channel the rock which everywhere underlies the harbor at a slight depth, by its outcropping, has decreased the general 12-foot depth of the channels to from 7 to 9 feet. The pres-

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ent project for the improvement of the harbor was adopted in 1883, and contemplates the formation of a channel 200 feet wide and 10½ feet deep through these shoals. An appropriation of $5,000 was made in 1884 for work under this project. With this a cut was made partially across one of these shoals. This cut has remained clear.

In act approved August 5, 1886, $7,000 were appropriated for continuing this improvement. This amount was applied to re-opening a cut through the middle ground and changing its direction so as to insure greater permanence. Operations were begun on October 5 and completed October 29, 1887; 12,944.7 cubic yards of soft material were removed, giving a cut 1,200 feet long, 70 feet wide, and 10.7 feet deep. An examination of the cut made June 13, 1888, shows that very little shoaling has taken place.

The estimated cost of completing the project by dredging is $46,500.

July 1, 1887, amount available		$6,717.81
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,514.47	
July 1, 1888, outstanding liabilities	97.75	
		6,612.22
July 1, 1888, balance available		105.59
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		7,605.59
Amount (estimated) required for completion of existing project		46,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O 10.)

11. *Suwance River, Florida.*—A project for its improvement was adopted in 1880. It contemplates the formation of a channel 150 feet wide and 5 feet deep, from the Gulf (through the bars at the passes) as far up the river as New Branford (Roland's Bluff). From there to Ellaville the channel is to be 60 feet wide and 4 feet deep.

Up to June 30, 1886, $17,940 had been expended under contracts in dredging in the east pass. A channel 5,835 feet long, 60 feet wide, and 5 feet deep at mean low water had been cut.

By act of August 5, 1886, $5,000 were appropriated for this work. During the fiscal year ending June 30, 1887, the channel between New Branford and Luraville was cleared and opened to the full size and width, excepting at three points, where the channel has a minimum width of 35 feet and depth of 3 feet. Work was stopped by high water.

During the past fiscal year work was confined principally to rock blasting at Double Island and Strip Jacket Shoals, between Luraville and New Branford. A channel has been blasted through these shoals having an average width of 60 feet and depth of 4 feet.

The work thus far done has rendered navigation throughout the year possible for boats drawing 2 feet of water between the mouth of the river and Luraville, 20 miles above New Branford.

July 1, 1887, amount available		$2,009.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,530.97	
July 1, 1888, outstanding liabilities	35.25	
		1,566.22
July 1, 1888, balance available		443.66
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,443.66

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Amount (estimated) required for completion of existing project	$17,158.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,200.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O 11.)

12. *Removing sunken vessels or craft obstructing or endangering navigation.*—An examination made in March, 1888, showed that obstructions endangering navigation existed at the following points, viz:

(1) Wreck of a United States transport, 18 miles south of Palatka.

(2) Portion of wreck of steamer *Maple Leaf*, 15 miles south of Jacksonville.

(3) Wreck of German brig near jetty channel, St. John's River, Florida. Authority to take the necessary steps for the removal of these obstructions, at an estimated cost of $5,890, was granted April 23, 1888.

On May 2, 1888, application was made to postpone the work of removal till fall. This application was approved by the Department on May 10, 1888.

(See Appendix O 12.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Captain Black was charged with and completed the following surveys, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 87, Fiftieth Congress, first session:

1. *Saint Augustine, Florida, for a deep-sea channel on the outer bar.*—(See also Appendix O 13.)

2. *Punta Rassa Harbor, Florida.*—(See also Appendix O 14.)

IMPROVEMENT OF CERTAIN RIVERS IN THE STATES OF FLORIDA, GEORGIA, AND ALABAMA.

Officer in charge, Capt. R. L. Hoxie, Corps of Engineers.

1. *Apalachicola River, Florida.*—The approved project for the improvement of this river contemplated securing a channel 100 feet wide and 6 feet deep at low water, by removing snags and overhanging trees as well as widening and straightening Moccasin Slough.

The improvement is completed as projected, the river being in a good navigable condition, and only requiring the removal of the annual accumulation of snags and overhanging trees and such work as can be done with the amount of $2,000, which has been estimated as necessary annually for preserving the improvement.

The balance available and the appropriation asked for are to be applied to preserving the improvement by the removal of obstructions according to the project.

July 1, 1887, amount available	$687.58
July 1, 1888, balance available	687.58
Amount appropriated by act of August 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,687.58

Amount (estimated) required for maintenance of existing project	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 1.)

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2. *Apalachicola Bay, Florida.*—A bar existed at the mouth of the Apalachicola River, extending from one-half mile below the town of Apalachicola, Fla., to the lower anchorage. The minimum channel depth of water over this bar was 3½ feet. The plan of improvement was the deepening of the channel to 11 feet with a width of 100 feet (see the Annual Report of the Chief of Engineers for 1879, pages 823 and 824), at an estimated cost of $100,000.

The expenditure of $66,756.51 of the amount appropriated for this work has resulted in a channel-way 3,635 feet long, 60 feet wide, and 9 feet deep at mean low water on the 18th of August, 1887. To complete the project about 150,000 cubic yards of material remains to be dredged.

The results have not been satisfactory. It has been thought that if the cut upon this bar could be carried through is with one appropriation the silting of the channel would take place much less rapidly.

July 1, 1887, amount available		$3,223.69
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,980.20	
July 1, 1888, outstanding liabilities	16.05	
		2,996.25
July 1, 1888, balance available		227.44
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		20,227.44
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 2.)

3. *LaGrange Bayou, Florida.*—The plan of improvement adopted was made pursuant to an examination of this bayou in 1881, under an act of Congress approved March 3, 1881, and contemplates the deepening of the channel through the bayou, so as to admit of the passage of vessels drawing 4½ feet at mean low water, the work to be done by dredging.

Up to June 30, 1888, there had been expended on this work the sum of $2,000, allotted from the appropriation of $20,000 made by an act approved August 2, 1882, for the improvement of the Choctawhatchee River, Florida, the two improvements being closely related. The result has been to secure a channel 5 feet in depth at mean low water.

July 1, 1887, amount available	$2,000.00
July 1, 1888, balance available	2,000.00
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	5,000.00

(See Appendix P 3.)

4. *Harbor at Pensacola, Florida.*—The plan of improvement adopted in 1881 contemplates dredging a channel 300 feet wide and 24 feet deep at mean low water across the inner bar for temporary relief of the navigation of this harbor, and the preservation of the site of old Fort McRee, by the construction of suitable works of shore protection, with a view to retaining this position for defensive purposes and preventing further changes in the tidal currents through the continued abrasion of the shore at this point.

The expenditure up to June 30, 1888, of $213,130.02 has resulted in obtaining temporarily a channel 120 feet wide and 24 feet deep at mean

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low water across the shoal inside the bar, and in stopping the abrasion of the shore-line at Fort McRee. This channel was not maintained by the tidal currents, and on June 30, 1888, was reported to be about 22 feet in depth at mean low water, showing no diminution in depth during the past year and a gain of 2.6 feet over the depth existing when the work was commenced. The width of this channel diminishes continuously by the advance of the Middle Ground Shoal upon its northern border.

An annual outlay will be necessary to maintain the dredged channel until the permanent improvement of this harbor shall have been authorized by Congress.

The enforced cessation of work on account of no appropriation for the fiscal year ending June 30, 1888, has resulted in further injury to the jetties and the postponement of relief to navigation.

July 1, 1887, amount available		$11,424.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,554.85	
July 1, 1888, outstanding liabilities	684.14	
		10,238.99
July 1, 1888, balance available		1,185.84
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,185.84
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 4.)

5. *Choctawhatchee River, Florida and Alabama.*—The present plan of improvement was adopted in 1872 and modified in 1880, pursuant to an examination made under the act of March 3, 1879. It contemplates the improvement of the river from its mouth to Newton, Ala., an estimated distance of 252 miles, so as to obtain a low-water navigable channel from its mouth to Geneva, and a navigable high-water channel from Geneva to Newton, Ala.

The expenditure up to June 30, 1888, of $84,788.84, has resulted in giving a navigable channel at mean low water from the mouth of the river to Geneva, and a partially improved channel from Geneva to Pates Creek, a distance of 25 miles (12 miles below Newton, Ala.).

July 1, 1887, amount available		$5,284.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,073.82	
July 1, 1888, outstanding liabilities	276.39	
		3,350.21
July 1, 1888, balance available		1,934.77
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,934.77
Amount (estimated) required for completion of existing project		25,832.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 5.)

6. *Escambia and Conecuh Rivers, Florida and Alabama.*—The plan of improvement for this river, adopted pursuant to partial examinations and surveys made in 1878 and 1879, contemplates the removal of snags and sunken logs and other obstructions from the channel, closing cut-

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offs and cutting through rock shoals from the mouth of the river in Pensacola Bay to Indian Creek, an estimated distance of 273 miles, for the purpose of facilitating the movement of timber down the river affording at the same time facilities for steam-boat navigation.

The expenditure up to June 30, 1888, of $45,325.28 has resulted in dredging a channel through the bar at the mouth of the river, and in the removal of obstructions to navigation, so that at the present time the river is navigable at ordinary stages for steam-boats drawing 5½ feet of water from Ferry Pass to Skinner's Landing, a distance of 17 miles, and for boats drawing 3 feet to the Alabama State line.

July 1, 1887, amount available		$9,855.52
Receipts from sale of fuel to officers		22.50
		9,878.02
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,067.00	
July 1, 1888, outstanding liabilities	479.74	
		6,546.74
July 1, 1888, balance available		3,331.28
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		13,331.28
Amount (estimated) required for completion of existing project		25,430.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 6.)

7. *Oconee River, Georgia.*—The State of Georgia has expended about $35,000 for the improvement of this river. The first examination made by authority of the United States was in 1874, and a plan of improvement was subsequently adopted which contemplated the removal of logs and snags from the channel and cutting through rock-reefs where necessary, in order to secure a depth of about 3 feet at low water from the mouth of the river to Milledgeville, Ga. The result of the work done up to June 30, 1888, has been to enable steam-boats navigating this river to run on a stage of water 4 feet lower than that at which navigation was possible before the improvement, but it has not been possible to maintain this. On May 23, 1888, a steam snag-boat for joint use upon this river and the Ocmulgee was completed and delivered to the United States under contract with Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., immediately equipped for service and placed at work on the Oconee.

July 1, 1887, amount available		$7,776.25
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,661.09	
July 1, 1888, outstanding liabilities	388.93	
		6,050.02
July 1, 1888, balance available		1,726.23
Amount appropriated by act of August 11, 1888		12,500.00
Amount available for fiscal year ending June 30, 1889		14,226.23
Amount (estimated) required for completion of existing project		55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 7.)

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8. *Ocmulgee River, Georgia.*—The present plan of improvement is based upon an examination made in 1875, when the obstructions were found to be snags, sand and gravel bars, rock-reefs, overhanging trees, and submerged rafts, in a shifting and tortuous channel, with a varying depth of from 22 inches to 4 feet at low water. The project for the improvement of the river contemplates the removal of these obstructions.

The expenditure up to June 30, 1888, of $62,533.72 has resulted in securing a good navigable channel at low water between Hawkinsville and the junction of the Oconee, while many of the more serious obstructions have been removed, but it has not been possible to maintain this. On May 23, 1888, a steam snag-boat for joint use upon this river and the Oconee was completed and delivered to the United States under contract with Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., immediately equipped for service and placed at work on the Oconee.

July 1, 1887, amount available		$6,936.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,970.50	
July 1, 1888, outstanding liabilities	82.45	
		5,052.95
July 1, 1888, balance available		1,883.83
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		16,883.83
Amount (estimated) required for completion of existing project		55,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 8.)

9. *Flint River, Georgia.*—The present project for the improvement of this river was adopted in 1873 and modified in 1880, the object of the original project being to afford a channel 100 feet wide and 3 feet deep at ordinary low water from its mouth up to Albany, Ga., and of the modification to improve for high-water navigation that portion of the river between Albany and Montezuma. The river before the improvement was commenced was only navigable at low water from its mouth up to Bainbridge, and even that portion was narrow, crooked, and dangerous. The expenditure up to June 30, 1888, of $113,917.23 has resulted in obtaining a high-water channel from its mouth up to Albany and a low-water channel of the projected depth from its mouth up to Blue Spring Shoal, about 4 miles below Albany; also a partially completed high-water channel over that portion of the river between Albany and Montezuma.

July 1, 1887, amount available		$12,403.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,290.75	
July 1, 1888, outstanding liabilities	834.22	
		10,124.97
July 1, 1888, balance available		2,278.31
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		22,278.31
Amount (estimated) required for completion of existing project		63,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 10.)

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10. *Coosa River, Georgia and Alabama.*—A plan was adopted in 1875 to provide a channel not less than 80 feet wide and 3 feet deep at low water between Rome, Ga., and the Selma, Rome and Dalton Railroad Bridge, an estimated distance of 236 miles, increasing the depth over the lesser rock shoals and over sand and gravel bars by excavations and by works of contraction, and overcoming the more serious obstructions by the construction of locks and dams.

The expenditure up to June 30, 1888, of $461,155.50 has resulted in securing a fair navigable channel from Rome, Ga., to Greensport, Ala., and has nearly completed the work of improvement to the Coosa River coal-fields.

July 1, 1887, amount available		$23,999.52
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$21,455.02	
July 1, 1888, outstanding liabilities	1,603.52	
		23,058.54
July 1, 1888, balance available		940.98
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		60,940.98
Amount (estimated) required for completion of existing project, subject to revision		234,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 11.)

11. *Chattahoochee River, Georgia and Alabama.*—The present plan of improvement (adopted in 1873) contemplates a low-water channel 4 feet in depth and 100 feet in width from Columbus, Ga., to Chattahoochee, Fla., a distance of 162½ miles, by the removal of snags and other obstructions from the channel and overhanging trees from the banks by the excavation of rock shoals and by works of contraction.

The expenditure up to June 30, 1888, of $220,134.04 has resulted in securing a fair navigable channel between Chattahoochee and Eufaula at all seasons of the year, and between Eufaula and Columbus at all times, except during the prevalence of extreme low water. The limited annual appropriations for this improvement have not been sufficient to maintain the works of contraction constructed, nor to extend or modify them as required.

July 1, 1887, amount available		$16,504.67
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,620.50	
July 1, 1888, outstanding liabilities	554.27	
		14,174.77
July 1, 1888, balance available		2,329.90
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		22,329.90
Amount (estimated) required for completion of existing project		112,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 12.)

12. *Tallapoosa River, Alabama.*—The plan of improvement adopted pursuant to an examination and partial survey of this river, made under an act of Congress approved June 14, 1880, contemplated obtaining a

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navigable channel from the mouth of the river to the foot of Tallassee Reefs, 2 miles below the town of Tallassee, a distance of 48 miles, with a least depth of 3 feet and a width of 60 feet at low water, by the removal of logs and snags from the channel, cutting overhanging trees from the banks, excavating the prescribed channel through certain rock-reefs, and removing certain sand and gravel bars by works of contraction and by dredging.

The expenditure up to June 30, 1888, of $30,700.86 has resulted in clearing out all logs and snags from the river channel and improving one of the rock-reefs, so as to admit of navigation at a moderate stage of water for a distance of 48 miles from the mouth of the river.

July 1, 1887, amount available		$5,428.67
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,611.53	
July 1, 1888, outstanding liabilities	520.15	
		4,131.68
July 1, 1888, balance available		1,296.99
Amount appropriated by act of August 11, 1888		7,500.00
Amount available for fiscal year ending June 30, 1889		8,796.99
Amount that can be profitably expended in fiscal year ending June 30, 1890, for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		5,000.00

(See Appendix P 13.)

13. *Cahaba River, Alabama.*—Under the act of Congress approved June 23, 1874, and an act approved June 14, 1880, examinations and a partial survey of this river were made in 1874 and in 1880, pursuant to which the present plan of improvement was adopted. This contemplates a channel 60 feet wide and 3 feet deep at low water from the mouth of the river to Centreville, Ala., a distance of 88 miles, by removing logs and snags from the channel, cutting overhanging trees from the banks, protecting caving banks from further erosion, removing rock-reefs, gravel-bars, and sand-bars by excavation, and by works of contraction and widening the narrow portions of the river, all at certain specified points.

The expenditure up to June 30, 1888, of $29,698.15, has resulted in clearing the river channel of logs and snags and removing overhanging trees from the mouth of the river to Centreville, and in maintaining this degree of improvement up to the close of the fiscal year ending June 30, 1886. Since that time no work has been done because of the proviso in the river and harbor act approved August 5, 1886, that "no part of said sum ($7,500 appropriated for this work) shall be expended until the officer in charge shall have reported that the railroad and other bridges across said river have been provided with good and sufficient draw openings." These bridges continue to obstruct the navigation of the river, not having been provided with draw openings. The working plant of the Cahaba River has been transferred to the Escambia and Conecuh improvement. Legislation is recommended to remove these obstructing bridges.

It is proposed to apply the amount on hand and the appropriation asked for to the removal of logs and snags from the channel and overhanging trees from the banks and to the progressive improvement of the river channel in conformity with the modified project which is given in the letter of transmittal herewith, provided the existing legal impediments to the progress of this work shall be removed.

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July 1, 1887, amount available	$7,801.85
July 1, 1888, balance available	7,801.85
Amount (estimated) required for completion of existing project	157,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P 14.)

14. *Alabama River, Alabama.*—The plan of improvement adopted pursuant to an examination and partial survey of this river made under an act of Congress approved March 3, 1875, contemplated obtaining a channel 200 feet in width and 4 feet in depth at low water from the mouth of the Alabama, 50 miles above Mobile, to Wetumpka, Ala., a distance of 323 miles, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, protecting caving banks from further erosion and removing rock-reefs, gravel and sand bars by blasting, dredging, and works of contraction at certain specified points of the river. The expenditure up to June 30, 1888, of $142,712.56 has resulted in clearing the river channel from its mouth to Wetumpka of all logs and snags obstructing navigation, and in maintaining this degree of improvement. Works of contraction have been constructed to a limited extent, but it has not been practicable, with the funds available, to keep them in repair nor to extend them or modify them as required. For several years past operations have been almost exclusively confined to the removal of snags from the channel. Since the commencement of work in 1878, the removal of 10,660 of these obstructions has been reported.

July 1, 1887, amount available		$10,091.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,804.13	
July 1, 1888, outstanding liabilities	639.21	
		8,443.34
July 1, 1888, balance available		1,648.23
Amount appropriated by act of August 11, 1888		20,000.00
Amount available for fiscal year ending June 30, 1889		21,648.23
Amount (estimated) required for completion of existing project		65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix P 15.)

15. *Removing sunken vessels or craft obstructing or endangering navigation.*—Under authority of the Secretary of War, proposals were invited for the removal of the wreck of the ship *Bride of Lorne* from the entrance to Pensacola Harbor, Florida, and a contract awarded August 19, 1887, at a total compensation of $2,995.

The contractor claims that the work has been completed. But a fragment of wreck still remains at a distance of about 458 feet from the position of the ship. The officer in charge being of opinion that it is part of the same, payment has been suspended pending the decision of this question.

Under authority of the Secretary of War, proposals were invited for the removal of the bark *Laigia*, sunk near Quarantine Station, Pensacola Harbor, and a contract awarded at a total compensation of $950.

The work has been completed and the contractor paid in full.

The removal of these wrecks will greatly benefit the commerce of the port.

(See Appendix P 16.)

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EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

Under the provisions of section 6 of the river and harbor act approved August 5, 1886, Captain Hoxie was charged with resurvey of outer and inner bars at Pensacola, Fla., which has not yet been completed owing to insufficient amount of the allotment practicable for this purpose from the appropriation for examinations and surveys made by the act. The officer in charge, in a communication to this office dated March 7, 1888, recommended a specific appropriation of $5,000 for the purpose of making proper survey and examination at this locality, and his communication was transmitted to Congress from the War Department March 15, 1888, and printed as House Ex. Doc. No. 226, Fiftieth Congress, first session. (See also Appendix P 17.)

IMPROVEMENT OF THE HARBOR OF MOBILE, OF WARRIOR, TOMBIGBEE, AND BLACK WARRIOR RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY.

Officer in charge, Maj. A. N. Damrell, Corps of Engineers.

1. *Mobile Harbor, Alabama.*—The present project for the improvement of this harbor was adopted in March, 1880, the object being to afford a channel of entrance from the Gulf of Mexico to the city of Mobile of 200 feet width and not less than 17 feet depth at mean low water.

The channel had originally a minimum depth of 5½ feet through Choctaw Pass and 8 feet in Dog River Bar.

This was deepened by dredging, under appropriations from 1826 to 1852 of $228,830.68, to 10 feet through both.

In 1860 the channel in Choctaw Pass had shoaled to 7½ feet.

From 1870 to 1878 the channel was deepened by dredging to 13 feet, under appropriations amounting to $401,000.

On the present project the amount expended to June 30, 1887, is $747,561.10, and resulted in obtaining a channel with a minimum width of 140 feet and a maximum width of 300 feet, a minimum depth of 17 feet and a maximum depth of 23 feet.

The amount expended during the fiscal year ended June 30, 1888, is $2,281.06, and was used in construction of pile clusters to mark dredged channel, care and preservation of boats and property, and in making an examination to ascertain condition of dredged channel in June, 1888, there not being sufficient money available to accomplish anything on the improvement.

The channel has shoaled so that now the minimum depth is 14 feet and maximum 23 feet.

The act of August 11, 1888, making appropriation for this harbor, provides for continuing the improvement on enlarged project for securing a channel 23 feet deep and 280 feet wide. This channel was estimated to cost $1,500,000. (See Annual Report of the Chief of Engineers for 1885, page 1374.)

The amount available and appropriation asked for is to be applied to continuing the improvement in accordance with the modified project.

July 1, 1887, amount available	$2,438.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,281.06
July 1, 1888, balance available	157.84
Amount appropriated by act of August 11, 1888	250,000.00
Amount available for fiscal year ending June 30, 1889	250,157.84

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Amount (estimated) required for completion of existing project	$1,250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 1.)

2. *Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek.*—The present project for the improvement of this section of the river was adopted in 1886, the object being to afford a water-way for the transportation of coal in barges from the Warrior coal fields to the Gulf of Mexico.

The present natural channel is only navigable during very high water, and is even then extremely dangerous.

The amount expended to June 30, 1887, was $5,150.02, and resulted in completion of a survey for preparation of plans and estimates for doing the work, the final adoption of plans, and in commencing a survey for purchase of lands for lock-sites, etc.

The amount expended during the fiscal year ending June 30, 1888, is $6,495.33, and resulted in completing the survey for purchase of land for lock-sites, etc., and in making preparations for commencing the work of constructing Lock No. 1 by hired labor and purchase of materials by contract as far as possible.

After careful revision by the officer in charge, the estimate of the cost of this improvement has been increased to $741,670.

The amount available and that asked for will be applied to the construction of the locks and dams, beginning with Lock No. 1.

July 1, 1887, amount available	$101,099.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,495.33
July 1, 1888, balance available	94,604.65
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	194,604.65

Amount (estimated) required for completion of existing project	539,420.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 2.)

3. *Warrior and Tombigbee rivers Alabama, and Mississippi.—a. Warrior River, Alabama.*—The present project for the improvement of this river was adopted in 1875, the object being to obtain a channel 4 feet deep and 80 feet wide at ordinary low water from its junction with the Tombigbee up to Tuscaloosa.

The channel at that time was not navigable at low water and was much obstructed at a medium stage.

The amount expended to June 30, 1887, was about $99,145.42 (exact figures can not be given for the years 1875–1882, inclusive; the appropriation was made for the Warrior and Tombigbee rivers jointly, without any special allotment for each, and therefore no separate account was kept), and resulted in obtaining a channel safely and easily navigable at a stage of water fully 3 feet lower than was formerly practicable, enabling boats of 3 feet draught to run when the water is 1 foot above ordinary low water.

The amount of $16,940 was expended during the fiscal year ending June 30, 1888, in a survey of the river and the preservation of the im-

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provement previously made of 42 miles of river from a point one-half mile above the mouth to a point one-half mile below Millwood.

July 1, 1887, amount available	$17,242.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,940.00
July 1, 1888, balance available	302.96
Amount appropriated by act of August 11, 1888	18,000.00
Amount available for fiscal year ending June 30, 1889	18,302.96
Amount (estimated) required for completion of existing project	16,714.62
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 3.)

b. Tombigbee River, Alabama, from Walker's Bridge to Fulton.—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the "Tombigbee River to ascertain what improvement is necessary to make said river continuously navigable from Vienna, Ala., to Walker's Bridge, Mississippi," and the report thereon accompanies this report as Appendix Q 10.

The proposed improvement contemplates the removal of snags and overhanging trees to obtain a high water channel from Walker's Bridge to the mouth, at an estimated cost of $11,000.

The river and harbor act of August 11, 1888, appropriates $4,000 for this work, and a further sum of $4,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$4,000.00
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

c. Tombigbee River from Fulton to Vienna.—The project for the improvement of the river between Columbus and Fulton was adopted in 1873, the object being to give a good high-water navigation throughout by the removal of snags and overhanging trees.

The channel before improvement was not navigable at all from Fulton down to Cotton Gin Port. From Cotton Gin Port down to Aberdeen, about 35 miles, it was navigable for small barges carrying about 125 bales of cotton. From Aberdeen to Columbus, about 65 miles, navigation was difficult when the river was 12 feet above ordinary low water.

The project for the improvement of the portion of the river between Columbus and Vienna was adopted in 1879, the object being to afford a channel of navigable width 3 feet deep during ordinary low water.

Before the improvement was commenced the channel was much obstructed by snags and overhanging trees, and there was only 1 foot of water on some of the bars during ordinary low water.

The amount expended to June 30, 1887, was about $72,098.76 (exact figures can not be given for reasons stated in Warrior River Report), and resulted in the completion of the proposed improvement (during the year 1886 in preservation of improvement already obtained) of that section of the river from Fulton down to Columbus, and in giving such a channel from Columbus down to Vienna that navigation was possible

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on a 2-foot rise for boats drawing 3 feet, and the accomplishment of over one-half of the work projected.

The amount of $6,552.62 was expended during the fiscal year ending June 30, 1888, and resulted in the preservation of the improvement previously made by contract of 25 miles of the river from Rodgers Fields to Hancocks.

The amount available and the appropriation asked for are to be expended in continuing the improvement as projected, and it is expected will complete it.

July 1, 1887, amount available	$7,451.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,552.62
July 1, 1888, balance available	898.67
Amount appropriated by act of August 11, 1888	6,500.00
Amount available for fiscal year ending June 30, 1889	7,398.67

(See Appendix Q 3.)

d. Tombigbee River, below Vienna.—The project for the improvement of this portion of the river was adopted in 1879, the object being to afford a channel of navigable width and 4 feet depth at ordinary low water from the mouth up to Demopolis, and 3 feet deep from Demopolis up to Vienna.

Before the improvement was commenced the river was navigable from the mouth up to Bladen Springs, 143 miles above Mobile, during the entire year, but was obstructed by snags. From Bladen Springs up to Demopolis, 243 miles above Mobile, navigation was suspended about two months yearly during low water.

From Demopolis up to Vienna the channel was much obstructed by snags and overhanging trees, and the water was so shoal on the bars that navigation was only attempted on a considerable rise. A railroad bridge at Jones's Bluff also gave considerable trouble.

The amount expended to June 30, 1887, was about $95,696.59 (exact figures can not be given, for reasons stated in Warrior River report), and resulted in obtaining an unobstructed channel with 3 feet depth of water from the mouth up to Tompkins Bluff, 197 miles above Mobile, with 2 feet depth up to Kirkpatrick's, 260 miles above Mobile, and 1 foot depth (all at ordinary low water) up to Vienna, and in defraying expense of watching and caring for the public property, and on a survey. A considerable portion of the sum has been used in preservation of the improvement previously made.

The amount expended during the fiscal year ending June 30, 1888, is $10,762.72, and resulted in the preservation of the improvement of 47½ miles of river between Bee Tree Bar and Singleton by contract.

The amount available and the appropriation asked for are to be expended in continuing the improvement according to the project adopted, and will probably complete it.

July 1, 1887, amount available	$10,864.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,762.72
July 1, 1888, balance available	102.26
Amount appropriated by act of August 11, 1888	6,000.00
Amount available for fiscal year ending June 30, 1889	6,102.26

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Amount (estimated) required for completion of existing project	$6,888.38
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,900.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 3.)

4. *Noxubee River, Mississippi.*—The present project for the improvement of this river was adopted in 1880, the object being to afford a channel for small river steamers from its mouth up to Macon, Miss., of navigable width and depth during about nine months of the year, or when the water is above ordinary low-water stage.

The amount expended to June 30, 1887, was $38,679.95, and resulted in obtaining a channel partially improved from the mouth of the river up to Macon, and a wholly improved channel (according to project) from Macon down to a point 28 miles below and from the mouth of the river to a point 30½ miles above, giving a river 58½ miles wholly improved and 33 miles partially improved. The amount expended during the fiscal year ending June 30, 1888, is $4,783.85, and resulted in the full improvement of 7 miles of river, from a point 28 miles to a point 35 miles below Macon, so that there is now 65½ miles wholly and 26 miles partially improved.

Such obstructions as had lodged during the last high water in that part of the river from Macon down wholly improved up to June 30, 1887, were removed.

July 1, 1887, amount available	$6,320.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,783.85
July 1, 1888, balance available	1,536.20
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	6,536.20

Amount (estimated) required for completion of existing project	15,245.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 4.)

5. *Pascagoula River, Mississippi.*—The present project for the improvement of this river was adopted in 1886, the object being to afford a channel of navigable width and minimum depth of 12 feet at mean low water from Moss Point to the anchorage in the bay, and to maintain the river above Moss Point in its improved condition.

The channel before the improvement commenced had a least depth of 3 feet. This was increased to 7½ feet, with a width of 180 feet, by dredging, from 1878–1880, at a cost of about $45,000.

From the light-house near the mouth of the river throughout the entire length, there is a navigable channel, obtained by the removal of snags and overhanging trees, from 1881 to 1884, inclusive, at a cost of about $15,000.

The amount expended during the fiscal year ending June 30, 1888, is $23,117.70, and resulted in obtaining a channel, by dredging through the bar at the mouth of the river, with a minimum width of 135 feet and a maximum width of 205 feet, and a minimum depth of 9.5 feet at mean low water.

The officer in charge reports that it has been necessary to increase the estimate for the completion of this work owing to the hardness of a portion of the material to be dredged.

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The amount available and the appropriation asked for are to be expended in the further improvement of the channel according to project, and in the removal of such obstructions in the river above Moss Point as have lodged during the suspension of the work.

July 1, 1887, amount available	$23,605.25
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	23,117.70
July 1, 1888, balance available	487.55
Amount appropriated by act of August 11, 1888	27,000.00
Amount available for fiscal year ending June 30, 1889	27,487.55
Amount (estimated) required for completion of existing project	89,000.00
Amount that can be profitable expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 5.)

6. *Harbor at Biloxi, Mississippi.*—The present project for the improvement of this harbor was adopted in 1882, the object being to afford a channel of entrance from Mississippi Sound to the wharves at Biloxi, of navigable width and 8 feet deep. The channel before was 4½ feet deep at the shoalest part.

The amount expended to June 30, 1887, was $976.36, and resulted in making a survey of the bar from Mississippi Sound to Biloxi, for the purpose of locating the proposed channel.

The amount expended during the fiscal year ending June 30, 1888, is $16,177.05, and resulted in dredging a channel 8 feet deep throughout at mean low tide, and 126 feet wide from the 8-foot curve outside in Mississippi Sound, for a distance of 2,150 feet, thence 84 feet wide for a further distance of 2,000 feet, and thence 124 feet wide a further distance of 1,030 feet to the 8-foot curve in Biloxi Bay.

July 1, 1887, amount available	$16,523.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,177.05
July 1, 1888, balance available	346.59
Amount appropriated by act of August 11, 1888	18,500.00
Amount available for fiscal year ending June 30, 1889	18,846.59
Amount (estimated) required for completion of existing project	19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	19,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 6.)

7. *Pearl River, Mississippi, between Edinburgh and Carthage.*—The project for the improvement of this portion of the river was adopted in 1884, the object being to obtain a good high-water channel throughout for the use of steamers during six or eight months of the year.

Before the improvement was commenced navigation was only possible during very high water, and was even then troublesome.

The amount expended to June 30, 1887, was $3,637.04, and resulted in such improvement of the whole distance as to permit of the passage of steam-boats of 3½ feet draught with comparative ease and safety on a rise of 5 feet above ordinary low water.

The amount expended during the fiscal year ending June 30, 1888, is $1,058.59, and resulted in the full improvement of this portion of the

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river, from Edinburgh to Carthage, 24¾ miles, so that boats of 3½ feet draught can navigate safely on a rise of 5 feet above ordinary low water.

July 1, 1887, amount available	$1,113.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,058.59
July 1, 1888, balance available	54.92
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,054.92
Amount (estimated) required for completion of existing project	5,964.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 7.)

8. *Pearl River, Mississippi from Jackson to Carthage.*—The present project for the improvement of this portion of the river was adopted in 1880, the object being to obtain a channel of 5 feet depth and of navigable width throughout.

Before the improvement was commenced navigation, even during high water, was difficult on account of snags and overhanging trees.

The amount expended to June 30, 1887, was $18,769.40, and resulted in such improvement of 59 miles of river from Carthage down to Partins Bluff, that boats of 3 feet draught of water can navigate this distance on a 4-foot rise above ordinary low water.

The amount expended during the fiscal year ending June 30, 1888, is $1,979.62, and resulted in the improvement of 62 miles of river from Carthage down to a point 1 mile below Harvey's Bluff, so that light-draught boats can navigate this distance with comparative safety on a 3-foot rise above ordinary low water.

July 1, 1887, amount available	$1,980.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,979.62
July 1, 1888, balance available	.98
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,500.98
Amount (estimated) required for completion of existing project	26,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 8.)

9. *Pearl River, Mississippi, below Jackson.*—The present project for the improvement of this portion of the river was adopted in 1880, the object being to obtain a channel 5 feet deep at ordinary low water and of navigable width from the mouth of the river up to Jackson.

Before the improvement the river was not navigable at all at low water and was difficult at high water.

The amount expended on the work to June 30, 1887, was $87,307.50, and resulted in the complete improvement of that section of the river from the head of the cut-off near the head of West Pearl River down to the mouth at the Rigolets, a distance of 51 miles, and the partial improvement of the river from Jackson down to the cut-off, a distance of 264 miles.

The amount expended during the fiscal year ending June 30, 1888, is

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$4,807.95, and resulted in the closing of Farr Slough, situated 23 miles above the New Orleans and North Easton Railroad Bridge.

July 1, 1887, amount available	$4,817.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,807.95
July 1, 1888, balance available	9.55
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,009.55
Amount (estimated) required for completion of existing project	55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Q 9.)

EXAMINATION AND SURVEY FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the locality was worthy of improvement, Major Damrell was charged with survey of the *Tombigbee River to ascertain what improvement is necessary to make said river continuously navigable from Vienna, Ala., to Walker's Bridge, Miss.*, the results of which are still incomplete, but will be submitted when received.

For preliminary report on this survey see Appendix Q 10.

INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

Inspecting officers, Maj. W. H. Heuer, Corps of Engineers, to October 31, 1887, and Capt. W. L. Fisk, Corps of Engineers, since that date.

The inspecting officer in his annual report states that the channel required by law, viz, "through the jetties" at the mouth of South Pass "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," also "a channel having a navigable depth of 26 feet" through the shoal at the head of the pass, and "through the pass itself," has been maintained throughout the year. No dredging has been done in the jetties, pass, or vicinity since February, 1883.

The channel beyond the jetties is somewhat better than last year, being 250 feet wide between the 26-foot contours and 110 feet between the 30-foot contours, instead of 210 feet and 60 feet, respectively.

Over the fan-shaped area beyond the ends of the jetties, embracing 1¼ square miles, the deposit has averaged .31 foot, or an aggregate fill of 400,000 cubic yards.

No vessels have been aground in the pass or jetties during the year, although the channel has been no better than last year.

July 1, 1887, amount available	$1,502.39
Amount appropriated by act of March 30, 1888	8,800.00
	10,302.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,297.98
July 1, 1888, balance available	4.41
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,004.41

(See Appendix R.)

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IMPROVEMENT OF VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA, AND OF BAYOU PIERRE, MISSISSIPPI—IMPROVEMENT OF SABINE PASS, TEXAS.

Officers in charge, Maj. W. H. Heuer, Corps of Engineers, until October 31, 1887; since which date Capt. W. L. Fisk, Corps of Engineers.

1. *Tchefuncte River and Bogue Falia, Louisiana.*—The river is navigable for steamers drawing 5 feet to Old Landing, about 10 or 12 miles above its mouth, and then for lighter-draught schooners to Covington, about 2 miles further up on the Bogue Falia. The bar at the mouth of the river had a depth of 4½ feet on it at the lowest stage of the water. The project for the improvement of the river was made in 1880, and contemplated the removal of overhanging trees, logs, etc., in channel, and the dredging of the bar at its mouth.

The obstructions, such as overhanging trees, logs in bed, etc., were removed, but the bar at the mouth was not dredged, as it would be likely to reform.

To prevent this, or retard its reformation, the officer in charge in 1884 recommended the building of a breakwater, extending into the lake for 2,500 feet and then dredging a channel through the bar.

With the two appropriations of $1,500 each, made in 1881 and 1882, the obstructions below Covington were removed. Part of the unexpended balance was used for the construction of the breakwater extending 820 feet into the lake.

The original estimated cost of improving the river was $5,460, but this did not include building a breakwater across the bar. The project, as modified in 1884, is estimated to cost $20,400. This has not yet received the sanction of Congress.

At the close of the fiscal year ending June 30, 1885, $3,000 had been expended on this improvement, at which time the navigation had been improved for schooners to Covington in consequence of removal of snags and overhanging trees, and it is thought that the breakwater has retarded the drift of sand on the bar at the river's mouth.

Twenty-five hundred dollars was appropriated by Congress in August, 1886, to improve Bogue Falia, between Old Landing and Covington. Early in 1887 operations began, and channels were cut through the bars in this stretch of bayou 5 feet in depth and 30 to 60 feet wide, giving better navigation to schooners to and from Covington.

To carry out the project for making the mouth of the Tchefuncte a harbor of refuge, $19,000 will be required.

Otherwise no money for the further improvement of this stream during the fiscal year ending June 30, 1890, is required.

July 1, 1887, amount available	$727.13
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	600.00
July 1, 1888, balance available	127.13

(See Appendix S 1.)

2. *Tickfaw River and its tributaries, Louisiana.*—In 1879 Congress authorized an examination of this river. A project was submitted in 1881 to clean out the river and its navigable branches—the Natalbany, Blood, and Ponchatoula rivers—by removing logs, snags, trees, etc., at an estimated cost of $10,230.

In 1881–'82–'86 Congress made appropriations aggregating $6,000, and 20 miles of the Tickfaw and the Natalbany, to Springfield, the head

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of navigation, have been improved. Work was also done on the Ponchatoula as far as it was thought advisable.

The Blood River was also cleaned out as far as navigable. Only a little wood and some saw-logs are carried or floated on this stream.

The improvement is not permanent, as obstructions will reform in all these streams.

The work has been completed in accordance with the original project. The officer in charge calls attention to the fact that most of the obstructions in these rivers are caused by the careless felling of trees for lumber.

July 1, 1887, amount available	$290.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	120.00
July 1, 1888, balance available	170.04
Amount appropriated by act of August 11, 1888	1,000.00
Amount available for fiscal year ending June 30, 1889	1,170.04

(See Appendix S 3.)

3. *Amite River, Louisiana.*—Before improvement the river was obstructed by snags, sunken logs, and trees. One or two small steam-boats and a few sailing vessels were employed in the commerce of the river. In 1880 a project was made to remove obstructions above Bayou Manchac, so as to get 5 feet depth, as far as appropriations would permit. Eight thousand dollars was appropriated, and the improvement of 40 miles of river above Bayou Manchac was contracted for. The work was of little benefit to commerce. In 1881 $5,000 more was appropriated to continue the work. In 1883 the project was modified so as to improve the river below Bayou Manchac, and work was done upon about 8 miles of the river.

In 1886 $2,000 more was appropriated to continue the improvement. This was applied to that portion of the river below Bayou Manchac, and principally between there and Port Vincent. Work was resumed in November, 1886, and completed in January, 1887, and the channel cleared.

The improvement is not a permanent one, as new obstructions will form from the caving banks.

The estimated annual expenses of cleaning out this stream is $2,000.

The original estimated cost of the work was $23,760; of which $15,000 has been appropriated and $14,666.67 spent.

July 1, 1887, amount available	$333.33
July 1, 1888, balance available	333.33
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,333.33
Amount (estimated) required for completion of existing project	6,260.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,300.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 4.)

4. *Bayou La Fourche, Louisiana.*—The natural channel was much obstructed by snags, overhanging trees, shoals, and wrecks. The original project, adopted in 1879, had for its object the removal of these obstructions.

The amount expended on this work up to end of fiscal year ending June 30, 1884, was $24,998.24.

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The amount expended during fiscal year ending June 30, 1885, was $3,756.21 for care of property, gauge-readings, and continuing improvement. Much relief has been given to commerce by removal of snags, etc.

The project adopted is that for the canalizing of the bayou, connecting it with the Mississippi by a lock at its head. This improvement is estimated as costing $450,000, with $31,000 annual expense of maintenance, this including $22,500 interest on original cost of $450,000 at 5 per cent.

July 1, 1887, amount available	$79.61
July 1, 1888, balance available	79.61
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	50,079.61
Amount (estimated) required for completion of existing project	400,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1865 and 1867.	

(See Appendix S 5.)

5. *Bayou Terrebonne, Louisiana.*—This work was examined by direction of Congress in 1879. The estimated cost of the improvement was $18,800, afterwards increased to $38,800, and was to consist of dredging a channel 4 feet deep, and clearing out all obstructions to Houma, La.

The following amounts have been appropriated by Congress: in 1880, $10,000; in 1881, $8,800; in 1882, $7,000; 1886, $10,000; total, $35,800.

When this work was commenced in 1880, the Bayou Terrebonne, in many places, was but little more than a drainage ditch, being but 11 feet wide where the dredge commenced work. The first 7½ miles of dredging terminated about 15½ miles below Houma.

In 1882, work was resumed and continued to within about 10½ miles of Houma. In 1886, work was again resumed, and during the fiscal year 1886–'87, the channel was lengthened 4.1 miles. The dredge continuing work until December 17, 1887, carried the channel to the railroad depot at Houma and there dug a turning-basin, which completes the work according to the approved project and within the estimated cost, viz, $3,000.

To maintain will require annual dredging at an estimated cost of $1,000.

July 1, 1887, amount available	$3,891.13
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,371.46
July 1, 1888, balance available	519.67
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,519.67

(See Appendix S 6.)

6. *Bayou Plaquemine, Louisiana.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the mouth of Plaquemine, with a view to its connection with the Mississippi River by locks and also Bayou Plaquemine and other connecting streams to form the best route to Grand Lake, Louisiana. The report of the result of the survey is printed in Senate Ex. Doc. No. 21, Forty-ninth Congress, second

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session, and also as Appendix S 21, of the Report of the Chief of Engineers for 1887.

The proposed project provides for the opening of the water route indicated by removal of snags and dredging, and constructing a lock at the mouth of Bayou Plaquemine at an estimated cost of $1,708.250.

The river and harbor act of August 11, 1888, appropriates $100,000 for this work, and a further sum of $200,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$100,000.00
Amount (estimated) required for completion of existing project	1,608,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

7. *Bayou Courtableau, Louisiana.*—An examination was made of this stream in 1879. The estimated cost of improving it below Port Barré was $40,000.

In June, 1880, Congress appropriated $7,500 to commence work, the project being to close some of the bayous that at high water ran from the Courtableau and thus force all the water flowing out of the bayou over the Little Devil Bar at its mouth.

After this bar was removed, locks and dams were to be constructed so as to give slackwater navigation to Washington, La. In 1883, this estimate was increased to $78.500, and provided for a masonry instead of a timber lock.

In 1882 one dam was built on the Big Fordoche, another in the Little Fordoche, and trees were slashed in some of the smaller bayous with a view to checking the flow of water through them. The effect was to increase the depth of water over Little Devil Bar.

In 1884 one of the dams was cut and Little Devil Bar reformed. In 1885 this dam was rebuilt and the other dam which was damaged was repaired.

In 1886, these two dams were again repaired and another was nearly completed in Bayou English.

A sudden rise in the Atchafalaya prevented the work from being continued and a portion of the last was destroyed.

During the fiscal year 1887–'88, the Bayou English dam was repaired and completed, Bayou Mamzelle was closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased, early in November last, the bar was cutting out rapidly, there being then a channel of 3 to 5 feet, while when work begun there was one of but a few inches. However, at that time the closure of Old River prevented any communication with the Mississippi River.

Recent inquiry leads to the belief that the dams are all in good condition at this time, but the back water from the Atchafallaya is so high that nothing is known regarding the present condition of the bar.

It will be useless to attempt any work on lock construction until Little Devil Bar is gotten rid of.

The estimate for closing the bayous is $7,107.90.

July 1, 1887, amount available	$2,902.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding Suly 1, 1887	2,571.29
July 1, 1888, balance available	330.87
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,330.87

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Amount (estimated) required for completion of existing project	$7,107.90
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix S 10.)

6. *Calcasieu River and Pass, Louisiana.*—In 1874 and again in 1882–'83 dredged channels were cut through the flats in Calcasieu Lake above Calcasieu Pass.

The dredged channel was 8 feet deep and 70 feet wide by 7,500 feet long.

In 1885 this channel had again shoaled to a depth of 3½ feet and needed redredging, but an unfortunate wording of the appropriation, "Improving Calcasieu River," prevented its application to this work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and the river. Contracts were made in 1886 for building two lines of piles and planking about 120 feet apart and a mile or more in length, between which a channel 100 feet in width and 6 feet in depth was to be dredged, and the excavated material thrown outside of the lines of the piles.

The excavation of a channel 100 feet wide and 6 feet deep through a bar at the junction of the river and lake was included in the contracts.

Work was commenced on the lines of piles and planking in the winter of 1886. In the spring of 1887 operations were resumed and the pile-work and planking partially completed, when the contract was annulled January 3, 1888.

During this long delay the revetment was badly damaged by the teredo, and this showing the life of timber to be so short in that locality it was proposed to modify the project so far as to omit the revetment.

This was approved by the Chief of Engineers, January 12, 1888, and authority given to do the work with Government plant.

Under this authority work was begun in March, and is now progressing satisfactorily.

The results will not be permanent, but it is thought that the improvement on the lower bar will last much longer than heretofore.

July 1, 1887, amount available		$17,231.37
Forfeited to United States by annulment of contract		14.43
		17,245.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,376.28	
July 1, 1888, outstanding liabilities	632.80	
		11,009.08
July 1, 1888, balance available		6,236.72
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		16,236.72

(See Appendix S 11.)

9. *Bayou Pierre, Mississippi.*—The preliminary examination of this bayou was authorized by Congress and made in 1884.

A full report of the examination was published in the Annual Report of the Chief of Engineers for 1885.

Part of the bayou was deemed worthy of partial improvement by the removal of logs, snags, and overhanging trees. In August, 1886, Congress appropriated $5,000 for this work. With this money the snag-boat formerly in use on the Teché improvement, then no longer required for that work, was put in thorough repair and used for cleaning out the bayou.

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The channel contemplated in the project has been completed.

The improvement made will not be permament, as the same kind of obstructions are likely to reform at any time.

July 1, 1887, amount available	$1,052.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,034.22
July 1, 1888, balance available	18.42

(See Appendix S 12.)

10. *Sabine Pass, Texas.*—The object of this improvement is to obtain deep water at this locality so as to give an outlet to the products of eastern Texas and western Louisiana, and give a good harbor on the Gulf Coast. Dredging was done here in 1878 and 1880, but the excavated channels refilled. In 1882 a project was made to get deep water by means of two jetties of brush and stone, and to dredge between them if found necessary, the estimated total cost of the work being $3,177,606.50. The following appropriations were made: August, 1882, $150,000; July, 1884, $200,000; August, 1886, $198,750.

Work was commenced in 1883, and has continued since, when funds would permit.

The west jetty was built out continuously from the shore to a length of a little more than 3 miles, but was only completed to mean high-tide level for a length of 7,270 feet.

The greater part of the foundation course of the outer mile of this jetty has since been destroyed by the sea, in the absence of funds to properly protect it against damage. The other, or east jetty, foundation course is now 14,410 feet in length, measured from the shore end, and is practically completed up to high-water level for 14,100 feet of this length.

All the work during the past year has been confined to raising and extending this jetty. The depth of water originally on the bar was 6½ feet; the last survey shows the least depth to be 8¼ feet, which is a slight improvement since the last report. Work under the last contract was completed August 4, 1887, when the survey above referred to was made.

July 1, 1887, amount available	$41,081.23
July 1, 1888, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1887	39,277.00
July 1, 1888, balance available	1,804.23
Amount appropriated by act of August 11, 1888	250,000.00
Amount available for fiscal year ending June 30, 1889	251,804.23
Amount required for completion of existing project	2,051,000.00
Amount that can be profitably expended in the fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix S 15.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

Officer in charge, Maj. O. H. Ernst, Corps of Engineers, having under his immediate orders First Lieut. Geo. A. Zinn, Corps of Engineers.

1. *Entrance to Galveston Harbor, Texas.*—The present project for the improvement of this locality was adopted in 1874, modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit sea-going vessels of the deepest draught. The natural depth

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upon the outer bar was about 12 feet at mean low tide, and upon the inner bar about 13 feet. The amount expended during the year was $243,495.99. The total amount expended to June 30, 1888, including $100,000 subscribed in 1883 by the city of Galveston, is $1,825,278.83. It has resulted in deepening the channel over the outer bar to about 12¾ feet, and that over the inner bar to about 20½ feet. It is proposed during the coming year to build the shore branch of the south jetty to connect with high ground, and to extend the finished work seaward about 1 mile. During the fiscal year ending June 30, 1890, it is proposed to complete the south jetty now under construction to the crest of the bar, and to build a north jetty to the same distance.

July 1, 1887, amount available		$296,217.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$223,060.61	
July 1, 1888, outstanding liabilities	20,435.38	
July 1, 1888, amount covered by existing contracts	49,850.04	
		293,346.03
July 1, 1888, balance available		2,871.13
Amount appropriated by act of August 11, 1888		500,000.00
Amount available for fiscal year ending June 30, 1889		502,871.13
Amount (estimated) required for completion of existing project		6,200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix T 1.)

2. *Ship-channel in Galveston Bay, Texas.*—The present project for this improvement was adopted in 1871, and modified in 1877, the object being to excavate and maintain a channel 12 feet deep and 100 feet wide at bottom, through Galveston Bay from Bolivar Channel to Morgan's Cut, a distance of about 18.33 miles. The average natural depth of the bay was about 8½ feet, with a depth in some places of about 7 feet. The amount expended during the year was $33,099.12. The total amount expended to June 30, 1888, is $325,022.30. It has resulted in the excavation of a channel having an average depth of 14½ feet through Redfish Bar, a length of about 2 miles, which has maintained itself since 1883, and more recently in the excavation of a channel 12 feet deep and 100 feet wide, for a length of 11,770 feet immediately north of Bolivar Channel.

The estimate, $106,500, submitted for carrying on the work during the fiscal year ending June 30, 1890, is the amount required to complete the original excavation, and to maintain it one year. The work is not capable of permanent completion. It is estimated that an annual expenditure of about $80,000 will be required to maintain it, which may be reduced to $50,000 if the Government own the plant.

July 1, 1887, amount available		$154,576.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,513.58	
July 1, 1888, outstanding liabilities	6,585.54	
July 1, 1888, amount covered by existing contracts	114,199.00	
		147,298.12
July 1, 1888, balance available		7,278.70
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		107,278.70

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Amount (estimated) required for completion of existing project, and maintain one year	$106,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	106,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 2.)

3. *Trinity River, Texas.*—The present project for the improvement of this stream was adopted in 1873, the object being to afford a navigable channel 5 feet deep through the bar at the mouth and up to Liberty, a distance of 41 miles. The natural channel through the bar at the mouth was narrow and had a depth of but 4½ feet. A bar about 4½ miles below Liberty and numerous snags obstructed navigation. There were no expenditures during the year. The total amount expended to June 30, 1888, is $34,500. It has resulted in facilitating the entrance to the river, though the depth over the bar has not been increased. The interior navigation was temporarily relieved by the removal of snags and of the bar near Liberty. It is proposed during the coming year to repair and extend the revetments at the mouth of the river, and during the fiscal year ending June 30, 1890, to complete that work, and to deepen the channel to 5 feet by dredging. This will complete the project so far as it is necessary at this time. There are numerous snags in the river between Liberty and Moss Bluff, 21 miles below, but as this part of the stream is rarely used, and as a new supply of these obstructions may be expected annually, it is proposed to defer further work here indefinitely.

Amount appropriated by act of August 11, 1888	$12,500.00

Amount (estimated) required for completion of existing project	12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 3.)

4. *Buffalo Bayou, Texas.*—The present project for the improvement of this stream was adopted in 1880, the object being to straighten, widen, and deepen the channel to a depth of 12 feet, and a width of 100 feet at bottom, between the city of Houston and Simms's Bayou, 11 miles below, and to remove such snags, stumps, and overhanging trees as were obstructions to navigation. The natural depth was in many places not more than 6 feet, and the channel was narrow and tortuous. The amount expended during the year was $16,986.17. The total amount expended to June 30, 1888, is $117,662.20. It has resulted in clearing the channel of the most prominent snags, stumps, and overhanging trees, in easing some of the bends, and in removing such shoals as obstructed a 7-foot navigation. These obstructions are renewed in greater or less degree each year. The amount required for the completion of the original excavation is estimated at $267,000, subject to revision. The project is not capable of permanent completion.

July 1, 1887, amount available	$18,073.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,986.17
July 1, 1888, balance available	1,087.80
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	26,087.80

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Amount (estimated) required for completion of existing project subject to revision	$242,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890, submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

(Appendix T 4.)

5. *Mouth of Brazos River, Texas.*—The advisability of a further prosecution of this improvement under the project adopted in 1880, being questionable, the subject was submitted to Congress in a special report printed in House Ex. Doc. No. 109, Fiftieth Congress, first session. The total amount expended to June 30, 1888, is $142,098.43. It has not resulted in any useful effect upon the bar.

July 1, 1887, amount available		$17,916.06
July 1, 1888, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1887	$1,254.49	
July 1, 1888, outstanding liabilities	10.00	
		1,264.49
July 1, 1888, balance available		16,651.57

(See Appendix T 5.)

6. *Pass Cavallo, inlet to Matagorda Bay, Texas.*—The works heretofore constructed for the improvement of this locality have practically disappeared, and if resumed, must begin anew upon a new site at a largely increased estimate of cost. The total amount expended to June 30, 1888, is $292,050.22. It has not resulted in any useful effect upon the bar.

July 1, 1887, amount available		$37,404.84
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,950.06	
July 1, 1888, outstanding liabilities	5.00	
		1,955.06
July 1, 1888, balance available		35,449.78

(See Appendix T 6.)

7. *Aransas Pass and Bay up to Rockport and Corpus Christi, Texas.*—The present project for the improvement of this locality was adopted in 1879 and modified in 1887, the object being to fix the position of the pass and to provide a navigable channel at least 20 feet deep through the bar. In its natural state the pass was moving bodily at the rate of about 260 feet per year, and the channel depth over the bar varied from 7 feet to 9½ feet. The amount expended during the year was $95,449.78. The total amount expended to June 30, 1888, including $9,938.93 subscribed in 1883 by citizens of Rockport and Corpus Christi, is $489,006.73. It has resulted in partially checking the southwestward movement of the pass. It is proposed during the coming year to complete the protection of the southerly shore of the pass and during the fiscal year ending June 30, 1890, to begin the reconstruction of the south jetty. The amount required for the entire completion of the project is $1,571,293.72.

July 1, 1887, amount available		$97,631.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$72,758.51	
July 1, 1888, outstanding liabilities	22,691.27	
		95,449.78
July 1, 1888, balance available		2,182.20
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		102,182.20

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Amount (estimated) required for completion of existing project	$1,471,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 7.)

8. *Harbor at Brazos Santiago, Texas.*—The present project for the improvement of this locality was adopted in 1881, the object being to fix the position of the channel over the bar at the entrance and to deepen it. In its natural state the channel was shifting, and its depth varied from 6 feet to 8 feet. The amount expended during the year was $3,386.06. It was applied to a survey, recording commercial statistics, and reports. The total amount expended to June 30, 1888, is $188,590.23 (besides an appropriation of $6,000 in 1878, applied to removing a wreck). It has resulted in no useful effect upon the bar, and the works heretofore constructed have practically disappeared. It is proposed during the coming year to limit operations to merely keeping a record of commercial statistics.

The amount required for the entire completion of the project is $1,096,000.

July 1, 1887, amount available		$37,295.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,381.06	
July 1, 1888, outstanding liabilities	5.00	
		3,386.06
July 1, 1888, balance available		33,909.77
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		58,909.77

Amount (estimated) required for completion of existing project	1,071,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T 8.)

WESTERN RIVERS.

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

Officer in charge, Capt. J. H. Willard, Corps of Engineers.

1. *Red River, Louisiana and Arkansas.*—The present improvement was begun in 1872. At that time navigation above Shreveport, La., was almost impossible on account of the great raft. Low-water navigation between Shreveport and Grand Ecore, La., was affected seriously by the gradual enlargement of Tone's Bayou outlet, which depleted the main channel of the river below. The entire river from Fulton, Ark., to its mouth was greatly obstructed by snags, sunken logs, wrecks, leaning trees, etc., and the channel at the falls of Alexandria, La., was insufficient for the demands of commerce.

The project has contemplated the removal of the great raft, the closure of Tone's Bayou, the removal of snags and other obstructions, opening a channel through the falls at Alexandria, increasing the depth of channel at shoal places, and improving Alexandria Harbor.

The work from 1872 to the end of the fiscal year 1887 consisted of the removal of the raft, preventing its reforming, and clearing the river of

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obstructions. Several ineffectual attempts had been made to close Tone's Bayou, but nothing since 1882, when the dam then under construction was destroyed. The excavation at the falls of Alexandria was practically completed. The work for the protection of Alexandria Harbor was completed according to the project as far as the funds available would permit. This, in connection with the dam at the lower falls, has been of some benefit to the river bank at Alexandria. The field work of the survey from Fulton to the mouth of the Atchafalaya was completed between Fulton and Caspiana. The amount expended to June 30, 1888, was $800,158.17.

During the fiscal year 1888 the snag-boats *Meigs* and *Florence* were employed in the low-water season, the former removing obstructions below Shreveport in August and September, and the latter above Shreveport in August, September, and October. The *Florence* was called out again to remove jams during the floods of March and May. Operations were limited to the above by reason of the small amount available.

July 1, 1887, amount available	$18,245.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,403.47
July 1, 1888, balance available	1,841.83
Amount appropriated by act of August 11, 1888	65,000.00
Amount available for fiscal year ending June 30, 1889	66,841.83
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	100,000.00

(See Appendix U 1.)

2. *Survey of Red River.*—The act of August 5, 1886, in appropriating $75,000 for Red River, provided that $25,000, or so much thereof as may be necessary, shall be used in making a thorough survey of the river from Fulton, Ark., to the Atchafalaya River, and in completing the survey of Bayou Pierre, Louisiana. Of this amount $24,665.12 was expended to June 30, 1887 (see Report of Chief of Engineers, Appendix N, page 1450). It was estimated in this Report that an additional sum of $35,000 would be needed to properly complete this survey, and the act of August 11, 1888, appropriates this amount.

July 1, 1887, amount available	$334.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	334.88
Amount appropriated by act of August 11, 1888	35,000.00

3. *Cypress Bayou, Texas and Louisiana.*—This improvement includes the whole navigable channel, from Shreveport, La., to Jefferson, Tex., *via* Soda and Fairy Lakes and Cypress Bayou.

The first project consisted in cutting and dredging a high-water channel from Jefferson to Red River, which was completed in 1880.

The act of August 5, 1886, appropriated $18,000 "to complete the improvement." The project for application of this amount contemplated rebuilding the dredge formerly used on this work, and by means of this boat to straighten and mark the present channel, remove stumps therefrom, and re-open cuts by dredging.

During the fiscal year the work in Cypress Bayou proper, which includes the principal amount of dredging, has been completed. That

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remaining to be done consists in straightening and clearing the channel of stumps through the lakes to Shreveport.

The balance available is not sufficient for this purpose, but it is recommended that the work be continued, at a cost of $7,500.

July 1, 1887, amount available	$12,393.61
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,055.32
July 1, 1888, balance available	338.29
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 2.)

4. *Ouachita and Black Rivers, Arkansas and Louisiana.*—The improvement of Ouachita River was begun in 1871. Black River, the connecting stream between Ouachita and Red rivers, was added under the same head of appropriation by act of 1884. The present project contemplates the removal of wrecks, logs, snags, leaning trees, etc., obstructing navigation, and the improvement of shoal places between Camden, Ark., and the mouth of Black River.

The amount expended under present project to June 30, 1888, was $193,912.13. Besides the removal of obstructions, an increased depth of from 12 inches to over 3 feet was gained at some of the shoal places.

No funds were available for work during the past fiscal year.

No estimate for permanent improvement can be submitted, as obstructions are forming continually.

Amount appropriated by act of August 11, 1888	$20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 3.)

5. *Ouachita River, Arkansas, above Camden.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, an examination (no survey being necessary) was made of the Ouachita River above Camden, and the report thereon is printed in the Report of the Chief of Engineers for 1887, as Appendix U 27.

The proposed improvement consists in the removal of snags, cutting leaning timber, and building brush-dams at the shoals, at an estimated cost of $9,000.

The river and harbor act of August 11, 1888, appropriates $9,000 to complete the work.

Amount appropriated by act of August 11, 1888	$9,000.00

6. *Bayou D'Arbonne, Louisiana.*—The project for this improvement was adopted in 1884, and contemplates the removal of snags, logs, wrecks, leaning trees, etc., obstructing navigation from Stein's Bluff to the mouth, 42½ miles, at an estimated cost of $15,000.

The amount expended to June 30, 1888, was $7,000, which resulted in the removal of obstructions from about one-half of that part of the stream in which improvement is contemplated.

The small balance available at the beginning of the fiscal year was expended in removing obstructions from about 12 miles of the bayou.

But little work is required in the 29 miles above the mouth at present, and with the amount asked for the fiscal year ending June 30, 1890,

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it is proposed to continue the removal of obstructions up to Stein's Bluff.

The work is not permanent as new obstructions are forming continually.

July 1, 1887, amount available	$669.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	669.23
Amount appropriated by act of August 11, 1888	2,000.00
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 4.)

7. *Little River, Louisiana.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination (no survey being required) was made of the above stream, and the report thereon is printed as Appendix U 30 of the Report of the Chief of Engineers for 1887.

The contemplated improvement consists in the removal of sunken logs and cutting away overhanging trees from Catahoula Lake to Black River, at an estimated cost of $2,500.

The river and harbor act of August 11, 1888, appropriates $2,500 for the work.

Amount appropriated by act of August 11, 1888	$2,500.00

8. *Bayou Bartholomew, Louisiana and Arkansas.*—This improvement was begun in 1881, the project contemplating the removal of wrecks, snags, overhanging timber, etc., obstructing navigation between Baxter, Ark., and the mouth, a distance estimated to be 213 miles.

The amount expended to June 30, 1883, was $23,000. The work had extended nearly over the entire portion of the bayou included in the project, and lessened the dangers of navigation greatly. But no permanent improvement can be effected, as new obstructions are forming continually.

During the fiscal year about 48 miles of the bayou were worked over.

July 1, 1887, amount available	$1,883.45
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,883.45
Amount appropriated by act of August 11, 1888	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 5.)

9. *Bayou Bœuf, Louisiana.*—The project for improvement of this bayou was adopted in 1880, and contemplated the removal of snags, logs, leaning timber, etc., obstructing navigation between Wallace's Landing and its mouth, a distance of 280 miles. An examination of three outlets of the bayou near Point Jefferson, La., was made in 1884, and their closure recommended at a cost of $8,500.

The amount expended to June 30, 1888, was $15,482.75, exclusive of existing contracts. The removal of obstructions enabled boats to run to Point Jefferson, 19 miles below Wallace's Landing, during high water.

In August, 1887, an agreement was made with a planter in the vicinity of Point Jefferson to close the three outlets, so far as the funds available would permit, in connection with levee work he was perform-

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ing near by. Outlet No. 1 was closed, and No. 2 begun, but was discontinued by bad weather in December and nothing has been done since.

It is proposed to apply the available balance to closing the outlets.

No permanent improvement can be secured, as new obstructions are added from time to time.

July 1, 1887, amount available		$4,981.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,138.54	
July 1, 1888, outstanding liabilities	325.62	
July 1, 1888, amount covered by existing contracts	1,320.00	
		4,784.16
July 1, 1888, balance available		197.25
Amount appropriated by act of August 11, 1888		6,000.00
Amount available for fiscal year ending June 30, 1889		6,197.25
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		5,000.00

(See Appendix U 6.)

10. *Tensas River and Bayou Macon, Louisiana.*—The project for improvement of Tensas River was adopted in 1881, and contemplated the removal of logs, snags, leaning timber, etc., obstructing navigation from Dallas to its mouth, about 180 miles, at an estimated cost of $23,000. Bayou Macon, a tributary, was added under the same head of appropriation by act of 1884, and the project contemplates the removal of the same class of obstructions as in Tensas from Floyd to its mouth, about 130 miles, at an estimated cost of $17,000.

The amount expended to June 30, 1888, was $11,000, $7,000 of which had been applied to improvement of Tensas River and the balance to Bayou Macon.

Operations were continued in Bayou Macon from October 13, 1887, to the end of the month, when the funds were exhausted. The work consisted principally in destroying accumulations of drift. This placed the bayou in good condition for high and medium stages, but navigation can be improved by removal of sunken logs, etc., from the channel.

The work is not permanent, as new obstructions are forming continually.

July 1, 1887, amount available	$400.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.39
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,000.00

(See Appendix U 7.)

11. *Bayous Rondeway and Vidal, Louisiana, by removing obstructions.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, an examination was made (a survey being unnecessary) of the bayous above referred to, and the report thereon is printed in the Report of the Chief of Engineers for 1887, as Appendix U 29.

The improvement proposed is the removal of obstructions, chiefly leaning trees, from the canal and the part of Bayou Vidal which will remain open from the lake to the line of the levee proposed to be erected

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by State authority north of Lake Palmyra, etc., at an estimated cost of $1,000.

The river and harbor act of August 11, 1888, appropriates $1,000 for the work.

Amount appropriated by act of August 11, 1888	$1,000.00

12. *Big Black River, Mississippi.*—The project for this improvement contemplated the removal of snags, logs, wrecks, and leaning trees obstructing navigation between the mouth and Cox's Ferry, 130 miles above, at an estimated cost of $32,000. Such improvement can not be permanent, as new obstructions are added from time to time.

The first appropriation for this work, by act of 1884, was applied to removing obstructions in the first 75 miles above the mouth. No work has been done since.

The appropriation in the act of 1886 contained the following proviso: "No part of this appropriation shall be used until the State of Mississippi shall have first caused the bridges south of the Vicksburg and Meridian Railroad to be so constructed as not to obstruct the navigation of said stream." This requirement has not been complied with yet.

July 1, 1887, amount available	$5,000.00
July 1, 1888, balance available	5,000.00
Amount (estimated) required for completion of existing project	22,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 8.)

13. *Yazoo River, Mississippi.*—Work in this river was begun in 1873 by removing the wrecks of eleven steam-boats sunk during the war. The project contemplates the removal of wrecks, logs, snags, leaning trees, etc., which obstruct the channel throughout the entire length of the stream. No permanent improvement can be effected, as each flood brings new obstructions into the river, and others are added by sliding banks, etc.

The amount expended to June 30, 1888, was $157,006.56. The large number of wrecks and natural obstructions which limited navigation of the stream had been removed to such an extent that the river was navigable from its head to its mouth the entire year.

The snag-boat *Meigs* continued work during July, 1887, and was then transferred to Red River. At the close of operations the river was less obstructed and navigation safer than ever known. An attempt was made in September to deepen the channel over the bar at the mouth, but the funds available being insufficient the work was abandoned.

July 1, 1887, amount available	$3,960.45
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,967.01
July 1, 1888, balance available	993.44
Amount appropriated by act of August 11, 1888	32,000.00
Amount available for fiscal year ending June 30, 1889	32,993.44
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 9.)

14. *Tchula Lake, Mississippi.*—The project for this improvement was adopted in 1881, and contemplated the removal of snags, logs, leaning timber, etc., obstructing navigation, to enable light-draught steam-boats to enter the lake earlier in the season.

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The amount expended to June 30, 1888, was $8,999.22.

No work was done during the fiscal year.

No permanent improvement can be effected, as new obstructions are forming continually.

July 1, 1887, amount available	$519.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	518.40
July 1, 1888, balance available	.78
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	3,000.78
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,000.00

(See Appendix U 10.)

15. *Tallahatchee River, Mississippi.*—This improvement was begun in 1879. The project contemplated the removal of snags, sunken logs, and leaning timber obstructing low-water navigation below mouth of Coldwater River, a distance 165 miles, and the removal of a wreck lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000.

The amount expended under this project to June 30, 1888, was $27,500, and there had been expended above mouth of Coldwater $10,000. Before improvement the river from mouth of Coldwater to Yazoo River was navigable about six months of the year. Boats from the Yazoo now run to Sharkey's Landing, 100 miles above the mouth, the entire year.

No work was done during the past fiscal year.

Many dangerous obstructions remain, and others, caused by sliding and caving banks, are forming continually.

July 1, 1887, amount available	$114.74
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	114.74
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix U 12.)

16. *Steele's Bayou, Mississippi.*—The project for this improvement contemplates the removal of snags, logs, stumps, leaning trees, etc., obstructing high-water navigation.

The amount expended to June 30, 1888, for this purpose was $4,699.20.

Nothing was done during the fiscal year.

July 1, 1887, amount available	$590.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	289.98
July 1, 1888, balance available	300.80
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,800.80
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

(See Appendix U 13.)

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17. *Big Sunflower River, Mississippi.*—The project for improving this stream was adopted in 1879, and contemplated building wing-dams to scour a channel of from 3 feet to 40 inches over the bar, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of $66,000.

The amount expended to June 30, 1888, was $47,000. Obstructions were removed and an increased depth of channel of from 18 inches to 3½ feet gained at the bars where dams had been built. When work was begun in 1879 the stream was navigable about six months in the year. During 1885–'86 it was navigable all the year, but in 1886–'87 for about eight months only, on account of formation of new obstructions since work was stopped in January, 1885.

The work resumed in June, 1887, was continued until August 26, when the funds were exhausted. Obstructions were removed, and wing-dams built at various bars, giving increased depths of channel ranging from 12 to 30 inches. Operations extended up to Faisonia, about 144 miles above the mouth, considered ordinarily the head of navigation.

July 1, 1887, amount available	$2,955.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,955.16
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 14.)

18. *Big Hatchee River, Tennessee.*—This improvement was begun in 1880. The project contemplated the removal of logs, snags, leaning timber, etc., obstructing navigation from Bolivar, Tenn., to the mouth, about 240 miles, to render that portion of the river navigable for light-draught boats throughout the year. The improvement will not be permanent, as new obstructions form from time to time.

The amount expended to June 30, 1888, was $22,000.

No work was done during the fiscal year.

Economy would be subserved by expending in one season an amount sufficient to clear the river of obstructions, so as not to require further work for several years. Five thousand dollars can be applied profitably to this purpose during the fiscal year ending June 30, 1890.

July 1, 1887, amount available	$64.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	64.54
Amount appropriated by act of August 11, 1888	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix U 15.)

19. *Forked Deer River, Tennessee.*—This improvement was begun in 1883. The project contemplated the removal of snags, logs, leaning timber, etc., obstructing navigation from the mouth to Sharon, about 114 miles above, at an estimated cost of $19,250. Operations, however, have been extended to Jackson, the head of navigation, 81 miles above Sharon. The work will not be permanent, as obstructions are added from time to time.

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The amount expended on the South Fork to June 30, 1888, was $10,000.

No work was done during the fiscal year.

The obstructed condition of the main Forked Deer River prevents navigation of South Fork at least three months of the year.

The sum of $10,000 can be expended profitably in one season's work in these streams.

July 1, 1887, amount available	$117.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	117.24
Amount appropriated by act of August 11, 1888	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix U 16.)

20. *Water-gauges on the Mississippi River and its principal tributaries.*—Section 5252, Revised Statutes, authorizes and *directs* the Secretary of War to have water-gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in vicinity of certain points named and at such other places as he may deem advisable.

By the terms of the statute the sum of $5,000 was to be appropriated annually for these gauges. This amount, however, has not been appropriated regularly. In 1878 observations had to be stopped by reason of exhaustion of funds, but many observers continued the readings without compensation. In 1886, no appropriation being made for that fiscal year, the Mississippi River Commission paid the observers and repaired the gauges on the Mississippi to prevent the suspension of those important observations. Nearly all the permanent gauges require rebuilding and the bulletin-boards repairs and painting. Bulletins should be erected also at all stations on the tributaries.

During the fiscal year observations were continued at all the gauges, and inspection and repairs made as far as practicable with the funds available. The appropriation of August 5, 1886, was exhausted practically by September 30, 1887, but observations were continued voluntarily, with the understanding that the observers should receive no pay unless special appropriation was made, an estimate for which was contained in Senate Ex. Doc. No. 92, Fiftieth Congress, first session.

July 1, 1887, amount available		$1,628.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,618.28	
July 1, 1888, outstanding liabilities	10.64	
		1,628.92
Amount appropriated by act of August 11, 1888		9,600.00

(See Appendix U 17.)

IMPROVEMENT OF ARKANSAS RIVER; OF RIVERS IN THE STATE OF ARKANSAS, OF BLACK RIVER IN ARKANSAS AND MISSOURI, AND OF ST. FRANCIS AND LITTLE RIVERS, MISSOURI.

Officer in charge, Capt. H. S. Taber, Corps of Engineers.

1. *Red River above Fulton, Arkansas.*—The appropriation available is the first ever made for work above Fulton.

The project contemplates high and medium-stage navigation only,

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and proposes to attain this by operating a hand-propelled snag-boat of light draught between low and middle stages of water.

Three thousand one hundred and fifty-four dollars and forty-six cents had been expended up to June 30, 1887. During the fiscal year ending June 30, 1888, with the small balance remaining, a good beginning was made upon the project, nearly eight hundred dangerous snags (low water) having been removed. The direct benefits to navigation were very marked.

July 1, 1887, amount available		$3,828.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,664.84	
July 1, 1888, outstanding liabilities	75.00	
		3,739.84
July 1, 1888, balance available		88.50
Amount appropriated by act of August 11, 1888		3,000.00
Amount available for fiscal year ending June 30, 1889		3,088.50

(See Appendix V 1.)

2. *Little Red River, Arkansas.*—The only improvements ever attempted upon this river were made in 1872.

Prior to this work many overhanging trees and a large number of snags interfered with navigation in the lower reaches, and many bowlders obstructed flat-boat and raft navigation in the reach above the present town of Judsonia.

Most of the overhanging trees and snags were removed as high as Judsonia, and the bowlders remained untouched to the end of June 30, 1886.

The act approved August 5, 1886, appropriated $3,000. The amount estimated as actually necessary was $8,400; $400 for the bowlders; $8,000 for dredging a channel through the shoals.

The $400 for the removal of bowlders having been expended during the fiscal year ending June 30, 1887, and the balance being too small to build and operate a light dredge-boat, nothing was done during the fiscal year ending June 30, 1888, except to care for the property and records.

July 1, 1887, amount available	$2,587.10
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	200.00
July 1, 1888, balance available	2,387.10
Amount appropriated by act of August 11, 1888	5,400.00
Amount available for fiscal year ending June 30, 1889	7,787.10

(See Appendix V 2.)

3. *Removing obstructions in Arkansas River, Arkansas.*—Prior to the first improvements in 1833, shifting sand-bars, numerous drift-piles, and dangerous snags constituted the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper. Except for a few special reaches, like the Fort Smith and Pine Bluff, the general plan of improvement has consisted in snagging operations, including the cutting of overhanging trees, in building wing-dams to improve the shoals, and in surveys looking towards plans for its permanent improvement.

The appropriations to June 30, 1888, amount to $440,251.87. Of this there had been expended to June 30, 1887, $365,299.61.

During the fiscal year ending June 30, 1888, $2,178.28 were expended

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in the care of the property and the records, and in advancing the work on the maps of the river from Little Rock, Ark., to Wichita, Kans.

The removal of obstructions will be continued with the amount on hand and that asked for.

July 1, 1887, amount available		$2,426.95
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,986.28	
July 1, 1888, outstanding liabilities	192.00	
		2,178.28
July 1, 1888, balance available		248.67
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,248.67
Amount (estimated) required for completion of existing project, annually		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix V 3.)

4. *Arkansas River, Arkansas and Kansas.*—By act of August 5, 1886, $75,000 was appropriated for continuing the improvement of Arkansas River. According to the plan and recommendations in Appendix V 13, House Ex. Doc. No. 1, Forty-ninth Congress, first session, of which there was to be expended $8,000 at Pine Bluff, $13,000 at Fort Smith, $10,000 at Dardanelle, or so much thereof as may be necessary at these points.

The approved project for the expenditure of this sum is as follows:

At Pine Pluff the $8,000 to be used in extending and repairing the dikes, and for protecting the town front.

At Fort Smith the $13,000 is to be expended in erecting a permeable dike a little above the town to retain the channel along the city wharves.

At Dardanelle the $10,000 to be expended in erecting a permeable dike above the town to remove the sand-bar now in front of the wharves.

From Little Rock to the mouth, the balance, and so much as may not be required at the three places above specified, to be expended in the erection of permeable dikes at the worst places, looking towards the permanent improvement of the river to give at least a depth of 5 feet at extreme low water.

Before operations were begun at Fort Smith the old jetty at that place, built in 1877 and 1878, had so far disappeared as to render no service.

At Dardanelle a bad bar had formed along the town front, cutting off all approach to either wharf at low water or medium stage.

At Pine Bluff the condition before improvement was that at one point in the vicinity of the town a cut-off was threatened, at another a bar interfered with navigation at low water, and in the bend in front of the town the river was eroding the banks with a rapidity that threatened the town front. The works erected have, so far, produced the desired effect of arresting this erosion.

From Little Rock to the mouth of the river the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for boats drawing 2 feet of water. During the fiscal year ending June 30, 1888, $437.29 have been expended at Pine Bluff in the care of the property. No additional work has been required at that point. The works have rendered excellent service. Extensive filling has continued all along the dangerous points of the town front.

At Fort Smith, Ark., $148.63 was expended in caring for the prop-

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erty. No rises occurred until near the close of the fiscal year ending June 30, 1888, to test the dike erected here. These rises have been attended with very satisfactory results in the way of deposits.

At Dardanelle there were no rises after the completion of the dike of 300 feet that were sufficient to indicate what length of dike would accomplish the object in view and do no violence to the town front, until just prior to the close of the fiscal year.

At last accounts the dike described in the last annual report was doing excellent work, and it is probable that early in the next fiscal year developments will be such that the original project may be successfully completed.

From Little Rock to the mouth $34,589.13 were expended according to the approved project. The plant belonging to Pine Bluff, Fort Smith, and Dardanelle was utilized, and three of the worst places have been improved.

Good progress has been made also just above Little Rock in directing the channel through draw of the Baring Cross Bridge and keeping it next to the city wharves. It is believed that one or more short dikes will be required to complete this work.

To complete the project as set forth in Appendix V 13, House Ex. Doc. No. 1, Forty-ninth Congress, first session, $2,494,544 will be required to obtain a channel at least 200 feet wide and 6 feet deep at low water.

The Board of Engineers, in reviewing this project, estimate the cost of obtaining a depth of 4 feet at $40,000 per mile, or $6,400,000 for the 160 miles from Little Rock to White River Cut-off. The act of August 11, 1888, contains the following proviso:

That nothing herein contained shall authorize the Secretary of War to enter upon the project of improvement of said river, as set forth in the report of the Board of Engineers on improvement of the Arkansas River from Wichita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Ex. Doc. No. 234, Fiftieth Congress, first session.

July 1, 1887, amount available		$44,868.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$33,508.81	
July 1, 1888, outstanding liabilities	1,350.29	
		34,859.10
July 1, 1888, balance available		10,009.54
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		160,009.54
Amount (estimated) required for completion of existing project		2,344,544.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix V 4.)

5. *Petit Jean River, Arkansas.*—Before improvement this river was obstructed by snags, logs, drift-piles, overhanging trees, and shoals. The project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees and cutting up the snags, logs, and drift. The only appropriation made for this river was that of August 5, 1886.

Three thousand three hundred and six dollars and fifty-one cents had been expended to June 30, 1887, effectively carrying out the original project as high as Rocky Crossing, or about one-half the distance to Danville.

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During the fiscal year ending June 30, 1888, the entire balance of the above appropriation was expended in caring for the property and the records.

July 1, 1887, amount available	$199.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	199.49
Amount appropriated by act of August 11, 1888	2,500.00
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix V 5.)

6. *Fourche River, Arkansas.*—The improvement of this stream was begun in 1879. Prior to any improvement its channel was choked with snags, logs, and drift, and heavy timber overhung its banks. Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions, though the shoals, and here and there a snag, washed in since work was suspended in December, 1882, still offer serious obstacles to navigation at medium stages of water.

Fair progress had been made up to June 30, 1887, in carrying out the project, which provided for blasting a channel 50 feet wide and 2 feet deep through the shoals about 4 miles below Perryville, Ark. During the fiscal year ending June 30, 1888, the balance was expended in completing the project. The shoals were found to be more than double the length given from an old reconnaissance. Despite this, an effective channel 30 feet wide has been opened the entire length of the shoal.

July 1, 1887, amount available	$809.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	809.00

(See Appendix V 6.)

7. *White River, Arkansas.*—Prior to improvement, this river was choked with drift-piles, logs, and snags in its lower portion, and from Batesville up, gravel-bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation.

The originally adopted project consisted in snagging operations and blasting of ledges and bowlders, and dam building to remove gravel-bars or to close chutes. The first separate appropriation for this river was made by act approved July 5, 1884. At that time the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water, from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others prevented any navigation at ordinary stages of water.

The appropriations for this river have been united so often with those of the St. Francis, with the Black and St. Francis, and the Black and Little Red, that the amount expended on the White River alone to June 30, 1884, can not be exactly stated. The approximate amount is not under $170,000.

The present project provides for removing snags, bowlders, and other obstructions to navigation, building wing-dams to improve shoals, and a survey of the river, with a view to its permanent improvement, from Forsythe, Mo., to the mouth.

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Up to June 30, 1887, $46,575.24 had been expended. This completed the field work of the survey, removed many of the most dangerous snags from Batesville to the mouth, partially plotted the notes of the survey, improved many of the worst shoals between Batesville and Buffalo Shoals, rendering material though temporary aid to navigation for very light-draught boats.

During the fiscal year ending June 30, 1888, $4,784.41 were expended. The plotting of the field notes was completed, and plans and estimates for permanent improvement prepared, and a few snags were removed in the lower reaches. The officer in charge reports that the cost of improving this river as proposed by him will be $105,315 in addition to the amount already expended.

July 1, 1887, amount available		$6,430.76
Received from sale of fuel to officer		6.00
		6,436.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,239.91	
July 1, 1888, outstanding liabilities	544.50	
		4,784.41
July 1, 1888, balance available		1,652.35
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		26,652.35
Amount (estimated) required for completion of existing project		80,315.00
Amount (estimated) required for snagging annually		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		58,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix V 7.)

8. *Cache River, Arkansas.*—This is a new work. To comply with the requirements of the river and harbor act approved August 5, 1886, a preliminary examination (a survey being unnecessary) of the above-named river was made, and the report thereon printed in Appendix V 15 of the Report of the Chief of Engineers for 1887.

The contemplated improvement is to build and equip a hand-propelled snag-boat, with which to remove the snags, logs, etc., which obstruct the river, at an estimated cost of $7,000.

The river and harbor act of August 11, 1888, appropriates $7,000 for the construction of the boat and paying running expenses of the same.

Amount appropriated by act of August 11, 1888	$7,000.00

9. *Black River, Arkansas and Missouri.*—Before any improvements were made upon this river its channel was choked with logs and snags, and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draught boats. Its banks caved but little, and except at the shoals it had greater depth of water than is found in streams generally in its vicinity.

The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing-dams. A few sloughs were to be closed so as to confine the water to the main channel.

Up to June 30, 1887, $55,635.51 had been expended for these purposes, and good progress made toward connecting with some detached work near Poplar Bluff, Mo., *i. e.*, only 60 miles of unworked river intervenes.

During the fiscal year ending June 30, 1888, $606.89 were expended in the care of the property and the records.

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Eight thousand dollars will be required annually for two or three years to maintain free navigation.

July 1, 1887, amount available	$606.89
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	606.89
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project annually	8,000.00
Amount that can be profitably expended in the fiscal year ending June 30, 1890	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix V 8.)

10. *Black River, Missouri.*—The work upon the river has hitherto been done under the appropriation for improving Black River, Arkansas and Missouri, and is provided for in the item under that heading in the river and harbor act of August 11, 1888.

The above being the first appropriation made for the improvement of Black River independently, it may be classed as a new work, and a new project for its expenditure will be proposed accordingly.

The river and harbor act of August 11, 1888, appropriates $7,000 for the improvement.

Until a project can be prepared an estimate for the completion of this work can not be submitted. This will be done by a special report at a later date.

Amount appropriated by act of August 11, 1888	$7,000.00

11. *Saint Francis River, Arkansas.*—The first appropriation was made March 2, 1833, prior to which this river was choked with drift-piles, logs, snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulty of navigation.

The originally adopted project was principally for snagging operations, and attempts have been made to close up some of the many sloughs. Appropriations for this river having been united with the White River, exactly how much had been expended upon the St. Francis River to June 30, 1884, can not well be stated.

July 5, 1884, the first separate appropriation was made, amounting to $12,000. August 5, 1886, $8,000 more followed. Of these amounts $19,066.93 had been expended to June 30, 1887.

During the fiscal year ending June 30, 1888, $929.69 have been expended in the continuance of the original project.

July 1, 1887, amount available		$933.07
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$904.69	
July 1, 1888, outstanding liabilities	25.00	
		929.69
July 1, 1888, balance available		3.38
Amount appropriated by act of August 11, 1888		4,000.00
Amount available for fiscal year ending June 30, 1889		4,003.38
Amount (estimated) required for completion of existing project, annually		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix V 9.)

12. *St. Francis River, Missouri, from Greenville to the Arkansas State line.*—This is a new work. To comply with the requirements of the

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river and harbor act approved August 5, 1886, a preliminary examination was made of the St. Francis River between the points named (a survey being considered unnecessary), and the report thereon is printed in the Report of the Chief of Engineers for 1887. (Appendix V 17.)

The proposed improvement is the removal of the shoals below Greenville and the removal of snags and other obstructions to navigation by snag-boat at an estimated cost of $7,300.

The river and harbor act of August 11, 1888, appropriates $5,000 for this work, and a further sum of $2,300 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	2,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,300.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

13. *Little River, Missouri, from Hornersville to its junction with the St. Francis River.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination (a survey being unnecessary) was made of Little River, and the report thereon is printed as Appendix V 16 of the Report of the Chief of Engineers for 1887. The proposed improvement consists in the closing of one of the chutes forming the river by a dam and the removal of obstructions by a hand-propelled snag-boat at an estimated cost of $8,000.

The river and harbor act of August 11, 1888, appropriates $5,000 for the work, and a further sum of $3,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI AND MISSOURI RIVERS.—IMPROVEMENT OF THE MISSISSIPPI BETWEEN THE MOUTHS OF THE ILLINOIS AND OHIO RIVERS.—IMPROVEMENT OF OSAGE RIVER, MISSOURI AND KANSAS, AND OF GASCONADE RIVER, MISSOURI.

Officer in charge, Maj. A. M. Miller, Corps of Engineers.

1. *Removing snags and wrecks from the Mississippi and Missouri rivers.—Mississippi River.*—For the removal of these obstructions appropriations were made as early as 1824, and the project consisted in the building of boats suitable for pulling snags, etc., which were almost continually employed during favorable boating stages.

The total amount expended for this purpose can not be definitely given, as previous to the appropriation made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required. From March 3, 1879, when the first specific appropriation was made, up to June 30, 1887, $548,125.87 was expended for this purpose. The navigation of the river has been very materially improved by this method and the danger of accidents to boats lessened. During the fiscal year ending June 30, 1888, $17,302.29 was expended.

No appropriation having been made for carrying on this improvement during the fiscal year, but little work could be done. One snag-

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boat was employed between the mouth of the Missouri River and Vicksburg, Miss., removing obstructions. The boat worked two months and a half, removing 798 snags, cutting down 348 trees, and traveling a distance of 1,792 miles. All the worst obstructions to navigation were removed, and commerce was greatly benefited thereby.

With the appropriation asked for the fiscal year ending June 30, 1890, it is proposed to continue the snagging operations and rebuild one of the wooden snag-boats for wrecking purposes.

No definite amount can be stated, as required, to complete this project. During every high-water season new snags and other obstructions are brought down and lodged in the channel; the banks are also continually caving in the river, and it is necessary to cut the timber where this is threatened to prevent the trees being caved into the river and forming new obstructions. For this reason an annual appropriation is required to properly carry on these operations.

July 1, 1887, amount available	$21,074.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17,302.29
July 1, 1888, balance available	3,772.47
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	103,772.47

(See Appendix W 1.)

Removing obstructions Missouri River.—The necessity for the improvement of this stream was first recognised in 1832, as its navigation was rendered difficult and dangerous by numerous snags, etc., in the channel and leaning timber on the banks of the river.

The plan adopted for its improvement was the removal of these obstructions by snag-boats, and they have been used to great advantage.

The first appropriations having been made so as to cover the needs of several streams, the total amount expended on this river for the removal of obstructions can not be given. Since June 18, 1878, when the first specific appropriation was made, up to June 30, 1887, $456,306.46 was expended in that manner, greatly improving navigation during the low-water season.

During the fiscal year ending June 30, 1888, $3,445.29 was expended in watching and caring for the snag-boats. No appropriation having been made for continuing this improvement, no boat was sent to the river to remove obstructions, the balance on hand not being deemed sufficient for that purpose.

With the appropriation asked for fiscal year ending June 30, 1890, it is proposed to complete the outfit of new boat and continue the snagging operations, and it is expected that the worst obstructions can be removed and navigation rendered comparatively safe.

As new obstructions are continually brought down the river work is required every year, so that an annual appropriation is necessary.

July 1, 1887, amount available	$6,193.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,445.29
July 1, 1888, balance available	2,748.25

(See Appendix W 1.)

2. *Mississippi River between the Ohio and Illinois rivers.*—Work was carried on at Pulltight, Jim Smith's, and Sulphur Springs. Owing to lack of funds no other work could be undertaken. These works form parts

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of one connected whole, carried on under a general scheme of making the improvement of the river continuous, beginning at Saint Louis and working down-stream, reducing the river to an approximate width of about 2,500 feet, and protecting the banks from erosion. The work between the Illinois River and Saint Louis consists in the maintenance of a channel 6 feet in depth.

Horsetail.—Cross-sections were taken here to ascertain the amount of fill. The results shown were as follows: Area over which fill has taken place, 915 acres. Area above 15-foot stage, on which willows are growing, 589 acres. Average fill over whole area, 11.86 feet. Greatest fill, 40.5 feet. Amount of material deposited, 17,500,000 cubic yards.

The effect of this remarkable fill has been to render this portion of the river navigable for the largest boats during the entire year and to remove one of the most troublesome bars, Horsetail, where trouble was always met with at low stages. The improvement of this locality may be considered complete, with the exception of the closing of Carroll's Island Chute, which still needs attention.

Twin Hollows, west bank.—The present project for the improvement of this locality was adopted in 1881. It consists in the building up of contraction works in order to confine the water. A channel of not less than 8 feet at low water has been obtained. No work was done here during the season. Cross-sections of work taken in the spring show the area over which fill has taken place to be 361 acres, 251 acres above 15-foot curve. Amount of material deposited, 11,389,259 cubic yards; average fill, 19.5 feet; greatest fill, 41.2 feet. Willows are growing over the area above the 15-foot curve.

Pulltight.—The project for the improvement of this locality was adopted in 1881, the object being to afford a channel of 8 feet at low water. The river at this point has shown a tendency to make a crossing above the point originally projected, and a careful study of this locality was made and works laid out in conformity with this tendency. Two hurdles were built from the east bank. The upper one, No. 4, was 3,000 feet long, and the lower, No. 5, 2,100 feet long. The rapid rise in the river and large run of drift damaged the first so that it is continuous for only about 1,700 feet from the east bank. No. 5 was completed its full length, and now holds. Work was discontinued on No. 4, as it was not economical to work at so high a stage. This hurdle will be completed as soon as the stage of the river permits, and it is confidently expected that this crossing will be greatly improved for low-water navigation. The middle bar has already been partially removed and a large deposit of silt obtained behind the hurdles. The amount expended during the year was $81,875.34, and the total amount expended to June 30, 1888, was $205,475.74.

Chesley Island.—No work was done at this locality. The object of the improvement here was to hold the head of the island and close the chute on its west side. Considerable difficulty has been met in closing this chute; every run out of the ice and drift during the spring rise has damaged the work. This year, however, the work has held and caused a large accumulation of drift in the head of the chute, and a fill in the chute, which will cause it to be dry at about the 15-foot stage, and it is expected that this will continue until the chute is entirely closed.

Jim Smith's.—The project for the improvement of this locality consists in construction of contraction works. The work done during the year was the revetment of the artificial bank opposite the head of Chesley Island; 1,775 feet were protected and held from erosion. The channel in this locality has been good during the year. To complete

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work at this locality one hurdle is required to fill a vacancy left during construction for the accommodation of the steam-boat landing. The amount expended during the year was $18,824.98, and the total amount expended to June 30, 1888, was $327,939.44.

Sulphur Springs.—The project for improvement of this locality was adopted in 1881, and consists of contraction works. The hurdles constructed during the previous year were wattled, and a new hurdle, No. 16, built at the head of Foster's Island. This hurdle was extended from the shore of the island westward for a length of 1,620 feet, and stands completed. This completes the work at this locality except repairs. The ice damaged to some extent the hurdles constructed last season, to what extent can not be definitely stated until the water reaches a lower stage. The effect of the work has been very apparent. Large accumulations of material have been obtained behind the hurdles, in some places a fill of more than 20 feet, and the chute behind Foster's Island has been almost entirely closed for a 15-foot stage of river.

A reference to the plates, accompanying the report of the officer in charge, will give a graphic description of the progress and effect of the above works. The amount expended during the year was $25,246.98, and the total amount expended to June 30, 1888, was $177,964.24.

The original estimated cost of the work, as revised in 1883, was $16,997,100. The aggregate amount appropriated to June 30, 1888, is $3,739,600. The amount expended to June 30, 1887, is $3,521,508.50.

July 1, 1887, amount available		$216,173.02
Miscellaneous receipts		1,708.63
		217,881.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$122,195.19	
July 1, 1888, outstanding liabilities	28.09	
		122,223.28
July 1, 1888, balance available		95,658.37
Amount appropriated by act of August 11, 1888		300,000.00
Amount available for fiscal year ending June 30, 1889		395,658.37

Amount (estimated) required for completion of existing project	12,957,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix W 2.)

3. *Gasconade River, Missouri.*—This river was greatly obstructed by snags, logs, and leaning timber, which materially interfered with navigation. Work was commenced on this stream in 1880, and the project adopted for its improvement consisted in the removal of the snags and logs and the cutting of leaning timber and contraction works.

The amount expended to June 30, 1887, was $34,424.39, and at that time the navigation was much improved. During the fiscal year ending June 30, 1888, $3,013.64 was expended in constructing dams or training-walls at Round Island and Bock's Bar, in order to concentrate the water in the main channel of the river at those points. All troublesome obstructions were also removed.

The original estimate for the improvement of this stream was $50,000, of which $37,500 has already been appropriated, leaving an estimated amount of $12,500 to complete the project. This amount will probably be exceeded, as new obstructions are continually forming, and it will

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require a small amount each year to keep the channel open after the principal work has been done.

July 1, 1887, amount available	$3,075.61
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,013.64
July 1, 1888, balance available	61.97
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,061.97
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix W 3.)

4. *Osage River, Missouri and Kansas.*—The navigation of this stream was greatly interfered with by obstructions in the channel and shoal crossings. The original project, adopted in 1871, was to obtain a low-water navigation of 2 feet by means of dams and training-walls, but this was abandoned and no other definite project was adopted. The improvements have consisted in the removal of overhanging trees from the banks, and of snags from the bed of the stream, and the construction of wing-dams and training-walls. The amount expended to June 30, 1887, was $194,027.89, at which time the navigation was in a fair condition, the worst obstructions having been removed. During the fiscal year ending June 30, 1888, $1,816.63 was expended in watching and caring for plant and in reading gauge at Tuscumbia.

An annual appropriation is required to keep this stream in navigable condition by the removal of new obstructions that are brought down during the floods. No stated amount can be given as required to complete the improvement.

July 1, 1887, amount available	$5,972.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,816.63
July 1, 1888, balance available	4,155.48
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	9,155.48
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

(See Appendix W 4.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

The required preliminary examination of *Mississippi River at Rush Island Bend and Ivy Landing, Illinois, with a view to confining and deepening the channel*, was made by the local engineer, Major Miller, and not recommended for improvement at present, as this locality will, at the proper time, be treated as part of the general plan of improvement of the river. Report transmitted to Congress and printed in House Ex. Doc. No. 216, Fiftieth Congress, first session. (See also Appendix W 5.)

It appearing, after preliminary examination by the local engineer, that the locality was worthy of improvement, Major Miller was charged with and completed the survey of *Kaskaskia River, Illinois, from New Athens*

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to its mouth, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 216, Fiftieth Congress, first session. (See also Appendix W 6.)

IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE DES MOINES RAPIDS AND THE MOUTH OF THE ILLINOIS RIVER.

Officer in charge, Capt. E. H. Ruffner, Corps of Engineers.

The approved plan of operations consists in contracting the low-water bed of the river at localities which have more than one channel, or where there is insufficient channel depth. Island chutes are closed by brush and stone dams, and wing-dams of the same construction are built where it is necessary to confine the low-water width to narrower limits. The heads of islands and many caving banks are protected by brush-mats and rip-rap, or by the latter alone. Dredging has been resorted to where necessary. The contract system is partly used in construction, and the United States owns and operates a plant of its own. A steamer has been purchased and fitted up as a hydraulic dredge for the purpose of increasing dredging facilities.

During the season of 1887, contractors finished their contract at Gilbert's Island and Turner's Island, and the United States constructed works near Cap au Gris and Martin's Landing, and made repairs near Dixon's Landing. The exhaustion of the appropriation limited operations.

With the money asked for it is intended to continue work as outlined above.

July 1, 1887, amount available	$19,349.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,022.89
July 1, 1888, balance available	327.05
Amount appropriated by act of August 11, 1888	200,000.00
Amount available for fiscal year ending June 30, 1889	200,327.05
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	264,000.00

(See Appendix X.)

IMPROVEMENT OF THE NAVIGATION OF THE MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS, INCLUDING IMPROVEMENTS AT SPECIAL LOCALITIES BETWEEN THOSE POINTS—OPERATING AND CARE OF THE DES MOINES RAPIDS CANAL.

Officer in charge, Maj. A. Mackenzie, Corps of Engineers.

1. *Upper Mississippi River: Operations of snag-boats and dredge-boats, etc.*—There being but $4,588.63 available from this appropriation at the beginning of the fiscal year, an additional allotment for snagging-work was necessarily made from the general appropriation for improvement of the river between Saint Paul and Des Moines Rapids.

In July and parts of August and September, 1887, the snag-boat was employed removing snags and other obstructions and assisting interests of navigation between Saint Paul and the mouth of the Missouri River.

The total amount expended for snag-boat service on the Upper Mississippi River between Saint Paul and the mouth of the Missouri, to July 1, 1888, is $522,728.66.

As a result of the work of the snag-boat during past years, accidents

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and damage from snags, wrecks, and other similar obstructions have become exceedingly rare; while, previous to the inauguration of snagging-work, the wrecking of boats and barges, attended by much loss, was a common occurrence. The dangers from snags and similar obstructions are now so slight that, as a rule, no insurance is taken out against loss from such cause.

July 1, 1887, amount available	$4,588.63
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,677.29
July 1, 1888, balance available	1,911.34
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	26,911.34

(See Appendix Y 1.)

2. *Mississippi River, from Minneapolis to Des Moines Rapids.*—Under this appropriation is carried on the improvement of through navigation. Work has been in progress, under annually approved projects, since 1878, and very favorable results have been secured, showing that with a continuance of the work under liberal appropriations the low-water channel of the Mississippi between Saint Paul and the Des Moines Rapids can be made comparatively safe, convenient, and permanent. The interests for which the improvement is being made are very large and important.

During the past year work has been carried out by days' labor between Saint Paul and Hastings, in vicinity of Crooked Slough, between Read's Landing and Winona, on Rock Island Rapids, and between Otter Island and Nauvoo, and by contract between Homer and Queen's Bluff, between Guttenberg and Waupeton, and between Sand Prairie and Savanna. Temporary work of dredging was carried out at numerous points.

The records of eight years' work show that material used in the construction of dams and shore protections can be purchased far more advantageously in open market than by contract, and that the carrying out of a portion of the work by aid of Government plant has resulted in a saving, as compared with cost of contract work, of $160,614.35, or within $33,275.61 of the total amount expended for plant. It is a satisfaction to know that the efficient plant now on hand has been almost paid for by the saving it has effected in cost of work.

There has been expended to June 30, 1888, for the permanent improvement of through navigation, the sum of $1,496,725.16, or $2,906.26 per mile.

July 1, 1887, amount available		*$270,274.40
Received from sale of fuel		105.04
		270,379.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$204,871.21	
July 1, 1888, outstanding liabilities	282.70	
		205,153.91
July 1, 1888, balance available		65,225.53
Amount appropriated by act of August 11, 1888		600,000.00
Amount available for fiscal year ending June 30, 1889		665,225.53

* This amount differs from the balance reported in money statement of previous year. It includes $15,000 appropriated for Lake City, which amount at date of previous report was included under special head of "Harbors of refuge on Lake Pepin, Lake City, Minnesota;" and it excludes $388.24, expended in Washington from allotment of $15,000 for the practical test of the Adams flume, previous to June 30, 1887.

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Amount that can be profitably expended in fiscal year ending June 30, 1890	$1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 3.)

3. *Des Moines Rapids, Mississippi River.*—This work was commenced in 1866. The adopted plan provided for the building of a closed canal 8 miles long and for cutting an open channel in the rock-bed of the river over the remaining 4 miles of rapids. The canal was opened in August, 1877, though not fully completed, and has been in operation since that time. The work of the past year consisted in the continuation of the protection of the canal embankment. The work remaining to be done to complete the improvement in accordance with the approved project is as follows: Completing blasting and dredging in open canal; raising lock-walls of middle and lower locks; refilling and completing paving of canal embankment; building a sluice in embankment for removing sediment; building an office at lower lock, and completing lock grounds. The approved project provides for two sluices in canal embankment, but one of these sluices has been provided in connection with the dry-dock. The estimated cost of the sluice was $20,000. As built, the additional cost to dry-dock was $8,000. The arrangement, therefore, effected an estimated saving of $12,000, which is deducted from the amount required to complete work. The amount of $8,000 is retained in estimate, and this amount should be expended in connection with the completion of the dry-dock.

There has been appropriated and allotted for this work the sum of $4,517,950. There have been expended for work $4,492,835.09. The net cost to the United States has been, to June 30, 1888, $4,491,690.72.

July 1, 1887, amount available	$29,124.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,884.24
July 1, 1888, balance available	25,240.16
Amount appropriated by act of August 11, 1888	35,000.00
Amount available for fiscal year ending June 30, 1889	60,240.16

Amount (estimated) required for completion of existing project	8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Y 4.)

4. *Operating and care of Des Moines Rapids Canal.*—During the past year the Des Moines Rapids Canal was open for navigation two hundred and twenty-seven days, during which time there passed through it 595 steam-boats and 235 barges, carrying 8,330 passengers, 33,160 tons of merchandise, and 143,037 bushels of grain. There also passed through 166,827,752 feet of lumber, 34,505,000 feet of logs, 49,848,840 shingles, and 83,642,450 laths. The lumber traffic of the year was about the largest on record, owing to the extreme low water of 1887. During 1888 the water was high and but few boats passed through the canal.

Less material than usual was brought into the canal during the past year, but surveys show that a gradual filling up of canal is taking place, and the amount of dredging must be increased. Forty-seven thousand three hundred and thirty-three cubic yards of material were removed during the year. It is possible that the purchase or construction of a tow-boat for use with dredge will be necessary in the near future.

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A floating boom was built and placed this spring at the head of the canal to facilitate entrance.

The extreme high water of the past spring developed some weak places in the embankment and extensive repair to the same must soon be made.

The expenses of the year have been $42,802.35, of which amount $9,161.24 are chargeable to dredging and $1,327.32 to boom construction; $2,234 35 were expended for repair of the gates, which are getting quite old and must be replaced in a few years.

The estimated expenses for the coming year are $45,000.

The expenses of operating and care of the Des Moines Rapids Canal are provided for by an indefinite appropriation, made by act of March 3, 1881.

July 1, 1887, balance on hand	$1,849.75
June 30, 1888, amount drawn from Treasury under indefinite appropriation	42,000.00
	43,849.75
June 30, 1888, amount expended during fiscal year	42,802.35
June 30, 1888, balance on hand	1,047.40

(See Appendix Y 5.)

5. *Dry-dock at the Des Moines Rapids Canal, Mississippi River.*—The approved project for this work provides for the building on the river side of the Des Moines Rapids Canal, above Middle Lock, of a dry-dock 400 feet long and 100 feet wide, with gates giving an entrance into the canal 80 feet wide. The original estimate of cost was $125,000. There have been expended to date $108,750. No balance remains on hand.

All the embankment and masonry work are completed, and the construction of gates is well under way. To finish the work requires the completion of paving of embankment of the gates, of the concrete and timber of bottom of dock, and of the draining arrangements, also the putting up of pumping machinery and the removal of a portion of canal embankment.

In constructing the sluices of dock, the openings were made larger than was originally proposed, with a view to discharging through them the muddy water at times brought into the canal by Price's Creek. This work has increased the cost of the dock somewhat, but has made unnecessary one of the sluices planned for the canal embankment and estimated to cost $20,000. The additional expenditure should be considered as a credit from the appropriation for "Improving Des Moines Rapids" to the appropriation for "Dry-dock at the Des Moines Rapids Canal," to be drawn upon for the latter work, in case it is found to be impracticable to fully complete the dry-dock without exceeding the estimate.

The large plant owned by the United States and the entire commerce of the Upper Mississippi River will be benefited by this improvement.

July 1, 1887, amount available	$27,621.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	27,621.76
Amount appropriated by act of August 11, 1888	16,250.00

(See Appendix Y 6.)

6. *Harbor of Refuge on Lake Pepin, at Lake City, Minnesota.*—The project for this work proposed the building of a breakwater to protect and facilitate the landing of steam-boats and afford safety to rafts caught in the lake by storms.

In May, 1887, the work of reducing depth of water and cost, by building up a foundation of gravel, was commenced. During the year a

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breakwater, 871 feet long, of which 512 feet are crib-work, extending into the lake below the gravel point in front of Lake City, from the foot of Elm Street, was completed. This breakwater was given sloping side and end, which permits the ice to slide over the pier rather than push against it. This pier passed comparatively safely through a severe test this spring due to a combination of very high water, heavy ice, and severe storms. There have been expended on this work to June 30, 1888, from special appropriations, the sum of $20,000, and from an allotment from general appropriation a further sum of $11,985.23.

As the length of pier built is thought to be sufficient to properly protect the harbor at Lake City, and as the balance on hand from the allotment is sufficient to make repairs now needed, no further appropriation is asked for.

July 1, 1887, amount available	*$16,350.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	16,350.82

(See Appendix Y 8.)

7. *Harbor of refuge on Lake Pepin, at Stockholm, Wisconsin.*—The project for this work proposed the building of a breakwater to protect and facilitate the landing of steam-boats and afford safety to rafts caught in the lake by storms. A crib-work pier 579 feet in length was completed in 1885. During the spring of 1888 there was a higher stage of water in the lake than was ever before known at the time of the breaking up of the ice, and the ice, when it did break up, was as solid as in mid-winter. A violent storm, occurring at this time, drove the ice with great force against the pier, carrying off about 4 feet from its top.

The pier should be repaired as soon as possible, and in making such repairs sloping sides and end should be provided. The amount expended on this work to June 30, 1888, is $19,070.94.

July 1, 1887, amount available	$6,209.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilites outstanding July 1, 1887	280.33
July 1, 1888, balance available	5,929.06
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00

Submitted in compliance with requirement of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix Y 9.)

PRESERVATION OF THE FALLS OF SAINT ANTHONY AND IMPROVEMENT OF THE MISSISSIPPI ABOVE THE FALLS—IMPROVEMENT OF CHIPPEWA AND SAINT CROIX RIVERS, WISCONSIN, AND OF MINNESOTA RIVER AND RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA—RESERVOIRS AT THE SOURCES OF THE MISSISSIPPI—IMPROVEMENT OF THE MISSOURI RIVER FROM SIOUX CITY, IOWA, TO FORT BENTON, MONTANA, AND OF YELLOWSTONE RIVER, MONTANA AND DAKOTA.

Officer in charge, Maj. Chas. J. Allen, Corps of Engineers.

1. *Preservation of the Falls of Saint Anthony, Minnesota.*—The history and details of this improvement are given at length in the last Annual Report.

* This amount is $15,000 less than the balance given in the last Annual Report, the $15,000—appropriation of July 5, 1884—having been transferred to appropriation for "Improving Mississippi River from Saint Paul to Des Moines Rapids" on books of Treasury Department and considered as an allotment, rather than a special appropriation.

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No work was done during the past fiscal year, there being no funds for it. As there is no navigation dependent upon the preservation of the Falls, and as Congress has made no appropriation for that purpose since 1884, it is deemed proper to render no estimates for this work for the fiscal year ending June 30, 1890.

Total expended under the present project, including outstanding liabilities, $405,000.

July 1, 1887, amount in hand	$86.83
July 1, 1888, outstanding liabilities	86.83
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	210,000.00

(See Appendix Z 1.)

2. *Construction of lock and dam on Mississippi River at Meeker's Island, Minnesota.*—The river and harbor act of March 3, 1873, appropriated—

For construction of the lock and dam on the Mississippi River at Meeker's Island, Minnesota, according to the surveys and plans of the War Department, twenty-five thousand dollars: *Provided*, That all rights and claims in and to the land grant made to the State of Minnesota for the above work, by act approved July twenty-third, eighteen hundred and sixty-eight, shall be fully relinquished to the United States before any of this appropriation is expended.

None of this appropriation has been used, the required relinquishment not having been made, and the appropriation has been lying unused for fifteen years.

July 1, 1887, amount available subject to conditions in act	$25,000.00
July 1, 1888, balance available subject to conditions in act	25,000.00
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	897,121.46

(See Appendix Z 2.)

3. *Mississippi River above Falls of Saint Anthony, Minnesota.*—The present project, adopted in 1880, consists in improvement of the river mainly between Aitken and Grand Rapids, a distance of 165 miles, by removal of snags, bowlders, bars, and leaning trees from the channels, and construction of wing-dams, when necessary, to afford 3 feet depth during low-water stage, the cost being estimated at $54,127. The last appropriation for this improvement being that of $10,000, by the act of August 2, 1882, no work was done upon the channels during the past fiscal year for want of funds.

The total expended under the present project to June 30, 1888, including outstanding liabilities, is $35,000.

Before improvement commenced in 1880 the stream between Aitken and Grand Rapids was so obstructed that navigation was difficult and at times almost impossible for steamers of lightest draught. There is now a general depth in the improved channels of 3 feet at low water, but there are many snags, leaning trees, bowlders, and gravel-bars yet remaining to be removed, as they contract the channels and thus interfere with the movement of steamers at any stage of water.

July 1, 1887, amount available, including outstanding liabilities	$3.67
July 1, 1888, outstanding liabilities	3.67
Amount appropriated by act of August 11, 1888	10,000.00

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Amount (estimated) required for completion of existing project, viz, improvement between Grand Rapids and Conradi's shoals	$9,127.50
Amount that can be profitably expended in fiscal year ending June 30, 1890	9,200.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 3.)

4. *Reservoirs at headwaters of Mississippi River.*—The object of the reservoirs is to collect surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams. The reservoir project is the outcome of surveys and examinations made in 1869, 1874, 1878, and 1879. From the results of these examinations, and further examinations made in 1880, the first cost of constructing reservoir dams in Minnesota and Wisconsin was placed at $1,809,083. The cost of land and other damages to result from construction and operation of the proposed dams was not included in that estimate, as they could not be predicted with any approach to accuracy.

The present project consists in constructing reservoir dams at the headwaters of the Mississippi River in Minnesota, that locality having been selected for commencing the work in consequence of an appropriation made by the river and harbor act approved June 14, 1880, for construction of a reservoir dam at Lake Winnibigoshish, Minnesota, and for other reasons given in Appendix Y to the Annual Report for 1886. Four of the reservoirs have thus far been created.

During the past fiscal year, surveys and examinations were made upon which to base plans for increasing the lift of the Pokegama reservoir 2 feet, and from which to ascertain the feasibility and cost of creating a reservoir at Sandy Lake, Minnesota.

The four completed reservoirs were operated in the interest of navigation during the exceedingly dry navigation season of 1887. Without taking into consideration the liberal volume of water released from them prior to August, the effect of a continuous discharge of the stored-up water from them for eighty-six days in August, September, October, and November, when the Mississippi needed water, was, as estimated by the officer in charge, to increase the channel depth of the Mississippi River at Saint Paul from 1 foot to 1½ feet.

Some extension was made to the apron at the Pine River dam during the year.

Expended during the fiscal year, $12,583.09.

Expended upon this project to date, including expense of detailed surveys and examinations, hydrological measurements, land damages, awards to Indians, and care of the completed dams and of the Engineer property pertaining to them, $596,800.27.

July 1, 1887, amount available		$38,282.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,617.16	
July 1, 1888, outstanding liabilities	965.93	
		12,583.09
July 1, 1888, balance available		25,699.73
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		37,699.73

Amount (estimated) required for completion of existing project	1,174,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890, for care and maintenance	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 4.)

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5. *Chippewa River, including Yellow Banks, Wisconsin.*—This work consists in the construction of dams and jetties to confine the low-water volume to a practicable channel, and in revetment of caving bends between Eau Claire and the mouth of the river, a distance of 57 miles. The project was adopted in 1877, and its cost then placed at $75,790. Revised estimates in 1883, however, increased the estimate to $132,476.35, including in this latter all the expenditures from the commencement of the improvement. Further revision in 1887 showed the cost of completion to be at that date $55,522.96. The total expended to June 30, 1888, including outstanding liabilities, is $115,712.72.

The work for improvement performed during the past fiscal year consisted in some extensions to and repairs of wing-dams, jetties, and revetments.

By the works constructed for the improvement of the river a low-water depth of 3 to 4 feet has been maintained, where before they were undertaken the depth seldom exceeded 18 inches. The jetties at the mouth of the river have been of great benefit to raft and steam-boat navigation, in securing a stable channel of sufficient depth, where before improvement commenced there was a broad bar intersected by shallow, shifting channels, passable with difficulty at times of low water by steamers and rafts.

A number of bars between the mouth and Eau Claire still require improvement.

The object of the work at Yellow Banks is to prevent erosion of the high sand-banks or bluffs on the Chippewa River below Eau Claire, and thereby relieve the channels of this river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks.

The project for improvement was adopted in 1883. The estimated cost of the work was originally placed at $64,102.50. The estimate, however, as revised in 1883, was increased to $96,000, from experience as the work progressed. The protection work consists of revetment of piling and fascines. The revetment should be crowned with rock.

The total expended on the project to June 30, 1888, including outstanding liabilities, is $30,000.

Slight repairs were made to the works during the fiscal year, but no new protection work was undertaken, owing to want of funds.

July 1, 1887, amount available		$5,470.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,406.21	
July 1, 1888, outstanding liabilities	26.55	
		4,432.76
July 1, 1888, balance available		1,037.28
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,037.28
Amount (estimated) required for completion of existing project		77,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Z 5.)

6. *Saint Croix River, Wisconsin and Minnesota.*—The original project, adopted in 1878, contemplated removal of obstructions from the channels between Taylor's Falls, Minn., and Prescott, Wis. There was expended under this project $18,000.

The present project, adopted in 1880 and modified as to cost in 1882,

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consists, in addition to the removal of obstructions from the channel between Taylor's Falls and Prescott, in the contraction of the low-water channel into one of nearly uniform width, especially at the bars and crossings, by means of jetties of brush and stone, and dams of same materials to close island chutes and secondary channels. The estimated cost was $83,450.

No work could be undertaken during the past fiscal year for want of funds.

The work performed since the adoption of the present project has resulted in a least depth of 3 feet on the improved bars above Stillwater, and 4 to 5 feet on the bars below that place. At many places navigation has been made permanent where formerly it was uncertain, and in other places it has been made practicable where before improvement commenced it was impossible. Some bars yet require improvement and some of the existing works are in need of small repairs.

Expended under the present project to June 30, 1888, including outstanding liabilities, $64,362.32.

July 1, 1887, amount available		$458.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$312.49	
July 1, 1888, outstanding liabilities	8.32	
		320.81
July 1, 1888, balance available		137.68
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,137.68
Amount (estimated) required for completion of existing project		8,950.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		9,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Z 6.)

7. *Minnesota River, Minnesota.*—For want of funds no work for improvement was done during the past fiscal year. The last appropriation for this stream was made by the river and harbor act of June 18, 1878.

The river and harbor act approved August 5, 1886, authorized a survey of the Minnesota River with a view to its improvement by locks and dams. The survey was made in 1887, the report upon which is printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

Total expended under the last adopted project for improvement of this stream, $29,967.

July 1, 1887, amount available, including outstanding liabilities ($9)	*$42.00
July 1, 1888, outstanding liabilities	9.00
July 1, 1888, balance available	33.00
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June, 1889	10,033.00

(See Appendix Z 7.)

8. *Red River of the North, Minnesota and Dakota.*—The project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877, and amended as to cost in 1883, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars, at an estimated cost of $179,310. A revised estimate made in 1887 placed the cost of completing the improvement at $79,598.37.

* Deposited to credit of Treasurer of the United States, November 11, 1885.

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During the past fiscal year dredging was carried on upon the lower 8 miles of Goose Rapids, at points between the rapids and Grand Forks, and on bars to a point 62 miles by river below the latter-named point.

There have been expended upon the improvement to June 30, 1888, including outstanding liabilities, $160,212.52.

Before improvement the ruling depth upon bars between Moorhead and Goose Rapids, at ordinarily low water, was but 1½ feet; and below Grand Forks 2 feet, while between Moorhead and Abercrombie the navigation was at all times difficult. The channels for 80 miles below Moorhead, and on the lower half of Goose Rapids, and between Frog Point and Grand Forks, have been improved to afford, at ordinarily low water, 3 feet, and below Grand Forks for 62 miles, 4 feet of depth. The removal of snags and trees between Moorhead (opposite Fargo) and Abercrombie, a distance of 76 miles, improved that portion of the stream for navigation during high and medium stages of water.

July 1, 1887, amount available	$22,065.61
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,330.48
July 1, 1888, balance available	9,735.13
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	29,735.13
Amount (estimated) required for completion of existing project	59,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 8.)

9. *The Missouri River from Sioux City, Iowa, to Fort Benton, Montana.*—This work was in charge of Capt. C. B. Sears, Corps of Engineers, to April 16, 1888.

The work of improvement is at present confined to the extent of river between Fort Benton and Carroll, Mont., and consists in the construction of wing-dams and dams to close secondary channels, so as to contract the water-way where too wide and to raise the water on the rapids and thus reduce the slope; also in dredging out the heavier gravel-bars and in removing projecting rock and loose bowlders, where necessary, with the expectation of ultimately securing between Fort Benton and Carroll a navigable depth of 4½ feet at low water.

The original condition of the navigable channel between the points named was extremely bad at low-water stages, the depth only averaging 3 feet, the channel having many sharp turns and being obstructed in many places by projecting embedded rocks and loose bowlders.

The river from Carroll to Sioux City was, and is, bad during low-water stages, owing to unstable banks, shifting channel, moving sand-bars, and snags. The originally adopted project for the improvement comprised the removal of snags from the lower or sandy portion and on the upper or rocky portion the contraction of the water-way so as to afford a navigable channel of 4½ feet depth at low water. On this project the expenditure to June 30, 1886, was $202,456.87. At that date the channel for purposes of navigation was much better than at any previous period, and vessels loaded to 3½ feet draught could, by careful pilotage and hard rubbing on the bottom, reach Fort Benton.

During the year ending June 30, 1888, three dams were built at Shonkin Bar and six at Croconduuez, the former increasing the chan

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nel depth 6 inches and the latter increasing it 12 inches. Two small dams were also built near Rowe's Ranche, a few miles below the Crocondunez. Total expended during the year, $30,639.17. Total expended under the project, $262,458.53.

July 1, 1887, amount available		$30,639.17
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$30,359.83	
July 1, 1888, outstanding liabilities	279.34	
		30,639.17

Amount (estimated) required for completion of existing project* above Carroll	250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	100,000.00

(See Appendix Z 11.)

10. *Yellowstone River, Montana and Dakota.*—This work was in charge of Capt. O. B. Sears, Corps of Engineers, to April 16, 1888.

The original condition of the navigable channel of the Yellowstone was bad and unsafe, due to the existence of numerous swift rapids, to crooked and shallow channel at low water, and to the presence of rocks and loose bowlders. By removing the latter at the worst places and by confining the water to one channel so as to increase the depth on the rapids the river has been considerably improved for purposes of commerce. Up to July 1, 1886, $98,306.74 had been expended upon the improvement, and at that date the condition of the improved river was much better than at present, as the dams have received no repairs since that date and are broken in many places. No work for improvement has been done since the fiscal year ending June 30, 1886, owing principally to insufficiency of funds. The engineer property pertaining to the improvement was, however, put in repair and cared for. Total expended to June 30, 1888, $104,489.27.

July 1, 1887, amount available	$16,530.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,269.85
July 1, 1888, balance available	13,260.98

Amount (estimated) required for completion of existing project	106,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix Z 12.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Major Allen was charged with and completed the following surveys and examinations, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

1. *Mississippi River between Saint Paul and Saint Anthony's Falls, Minnesota.* (See also Appendix Z 13.)

2. *Minnesota River, with a view to its improvement by locks and dams.* (See also Appendix Z 14.)

3. *Red River of the North, Minnesota, from Moorhead to Fergus Falls.* (See also Appendix Z 15.)

*No project for river below Carroll, except snagging.

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IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

Officer in charge, Lieut. Col. J. W. Barlow, Corps of Engineers, with Lieut. H. E. Waterman, Corps of Engineers, under his immediate orders.

1. *Tennessee River.—a. Above Chattanooga.*—The present project is to blast a channel through the reefs, to reduce the sand and gravel bars, and to build riprap dams to contract the water-way, so as to obtain a safe, navigable channel having a depth of 3 feet at low water. The rocky bed and banks render the improvement practically permanent.

The snag and tow boat for use on this river and its tributaries was completed during the fiscal year, and was employed in towing stone-barges at Half Moon Island and in the removal of snags at other points along the river. Work was carried on at Baker's Shoals, Russell Shoals, and Caney Creek Shoals, constructing wing-dams and removing surface obstructions.

The total amount expended to June 30, 1888, including outstanding liabilities, is $215,947.70, which has resulted in giving an improved channel by removing or reducing obstructions, and thus lengthening the season of navigation.

July 1, 1887, amount available		$5,274.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,177.49	
July 1, 1888, outstanding liabilities	45.11	
		5,222.60
July 1, 1888, balance available		52.30
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,052.30
Amount (estimated) required for completion of existing project		59,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix A A 1.)

b. Below Chattanooga.—The section of the river from Chattanooga, Tenn., to Brown's Ferry, Ala., was obstructed by reefs, bars, etc., and had about 3 feet of water in the channel for eight or nine months in each year. From Brown's Ferry to Florence it was not navigable, the Muscle Shoals forming an absolute barrier, excepting when the river was at an unusually high stage. From Florence to mouth of the river the usual surface obstructions were found, with many shoals, having deep water between them.

The present project consists in building around the Big Muscle Shoals a canal 14½ miles long, 70 to 120 feet wide, and 6 feet deep, having nine locks, each 300 feet between gates and 60 feet wide, and an aqueduct over Shoal Creek 900 feet long, 60 feet wide, and 5 feet deep; in constructing a canal around the Elk River Shoals, 1½ miles long, with two locks; and in blasting a channel through the bed-rock and building wing-dams at Little Muscle Shoals, a modification of the original plan for a system of lockage; and in improving the most troublesome places above Decatur and below Florence.

The total amount expended to June 30, 1888, including outstanding liabilities, is $2,957,377.28, which has resulted in the improvement of the river, as follows:

The Little Muscle Shoals work, as modified, has been practically completed by cutting a channel through the bed-rock, 2½ miles long, and

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building wing-dams. It may, however, become necessary in the future to make modifications of the existing dams, or to build locks, as originally projected.

At Big Muscle Shoals and Elk River Shoals the eleven locks are built and all the miter-gates are in position. The five lower locks are to have drop-gates, one of which, at Lock No. 5, is already hung. The Shoal Creek Aqueduct is nearly finished; it sustained a severe test by the heavy floods of March last without injury. A dredge and dump-scows were built for service in dredging the canal-trunk and approaches.

Straightening the upper channel entrance to the Elk River Shoals Canal and raising the walls of Lock A to the level of its upper bay are recommended. The plans for the radical improvement of the Colbert Shoals and Bee Tree Shoals, by the construction of two locks and dams, have been submitted.

It is expected that both sections of the canal can be opened for the use of the public during the low-water season of 1889, provided that sufficient funds are made available without delay.

Attention is invited to the necessity of removing certain obstructions immediately below Chattanooga, and of making an instrumental survey of the river below that city.

July 1, 1887, amount available		$94,883.13
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$90,880.76	
July 1, 1888, outstanding liabilities	3,379.65	
		94,260.41
July 1, 1888, balance available		622.72
Amount appropriated by act of August 11, 1888		250,000.00
Amount available for fiscal year ending June 30, 1889		250,622.72
Amount (estimated) required for completion of existing project		1,548,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix A A 1.)

2. *French Broad River, Tennessee.*—After a course of about 121 miles in Tennessee, this river joins the Holston, near Knoxville, thus forming the Tennessee River.

Above the mouth of Nolichuky River it is not susceptible of improvement, except by building locks and dams, at a heavy cost, and the commerce, present and prospective, does not warrant such an expenditure. The present plan seeks to improve the channel so as to obtain a depth of 2½ feet at low water, from the mouth of the river to Leadvale, about 90 miles, the work consisting of channel excavation, clearing away of surface obstructions, and building wing-dams, where necessary, to contract the water-way.

The total amount expended to June 30, 1888, including outstanding liabilities, is $28,000, and has resulted in securing an improved channel below Dandridge, by giving an additional depth of water over several of the worst shoals.

July 1, 1887, amount available		$4,727.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,682.96	
July 1, 1888, outstanding liabilities	44.44	
		4,727.40
Amount appropriated by act of August 11, 1888		10,000.00

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Amount (estimated) required for completion of existing project.....$112,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix A A 2.)

3. *Little Tennessee River, Tennessee.*—This river rises in the Blue Ridge, and is an important tributary to the Upper Tennessee.

An examination was made in 1881, upon which is based the present plan of improvement, which is to remove surface obstructions, reduce rock-reefs and gravel-bars, and build wing-dams to contract the waterway so as to obtain a low-water channel 40 feet wide and 2 feet deep below the mouth of the Tellico River, a distance of about 13 miles.

No work has been done since December, 1883.

The total amount expended to June 30, 1888, is $5,000, which has resulted in securing an improved channel.

Amount (estimated) required for completion of existing project..... $18,724.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix A A 3.)

4. *Hiawassee River, Tennessee.*—This river is an affluent of the Tennessee. An examination was made in 1874. The natural channel is obstructed by rock-reefs, bowlders, snags, and overhanging trees.

The present plan is to obtain a navigable channel 40 feet wide and 2 feet deep at average low water from the mouth of the river to head of navigation, about 33 miles, by reducing the reefs and bars, removing surface obstructions, building wing-dams, etc.

No work has been done during the fiscal year.

The total amount expended to June 30, 1888, including outstanding liabilities is $34,000, and has resulted in obtaining an improved channel below Charleston.

Amount appropriated by act of August 11, 1888..... $1,000.00

Amount (estimated) required for completion of existing project..... 1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 1,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix A A 4.)

5. *Clinch River, Tennessee.*—The Clinch River rises in Virginia and enters the Tennessee near Kingston, Tenn. It is about 400 miles in length, 230 miles of which are in Tennessee.

The present plan of improvement consists in lengthening the season of navigation and in securing a safe channel, having a depth at ordinary low water of 2 feet to Clinton, 70 miles, and 1½ feet from Clinton to Walker's Ford, 75 miles. Above this point, to the Tennessee and Virginia State line, 85 miles, the only work that can be done to advantage is to reduce the ledges and remove surface obstructions sufficiently to assist the passage of flat-boats and rafts on the sudden rises or "tides" caused by heavy rains.

During the year work has been carried on principally at Cloud's Shoals, about 113 miles from mouth of river, by reducing the rock-ledges in channel and building wing-dams.

The channel of river between Cloud's Shoals and Hibb's Shoals—about 18 miles—has been cleared of snags, overhanging trees, fish-trap dams, etc. The Engineer officer in charge urges the importance of legislation or executive action in the matter of the building of fish-traps and trap-dams upon this stream, and calls attention to their character as serious channel obstructions. These dams appear to be authorized

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under the fish law of Tennessee, as amended by the legislature of that State in 1885.

The total amount expended to June 30, 1888, is $25,958.09, which has resulted in securing an improved channel at many of the principal obstructions, and practically safe navigation for rafts and flat-boats at stages of the river 2 or 3 feet lower than before channel-work was begun in 1880.

July 1, 1887, amount available		$4,425.90
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,313.15	
July 1, 1888, outstanding liabilities	70.84	
		4,383.99
July 1, 1888, balance available		41.91
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,041.91

Amount (estimated) required for completion of existing project	19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 5.)

6. *Duck River, Tennessee.*—This stream flows wholly in the State of Tennessee. Its length is about 250 miles. An examination, below Centreville, was made in 1879. Obstructions were found to nearly close the channel in places. Work began in September, 1880, removing snags, etc., reducing gravel-bars, and building wing-dams. No channel-work has been done since December, 1882. The total amount expended to June 30, 1888, is $13,000, and has resulted in securing a fair navigable channel, during the boating season, from Centreville to mouth of river, about 68 miles. The character of this stream is such that snags, fallen trees, etc., accumulate rapidly, and these obstructions should be removed after heavy floods.

Amount (estimated) required for completion of existing project	$22,118.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 6.)

7. *Cumberland River, Tennessee and Kentucky.—Below Nashville.*—The project for improving this section consists in deepening and widening the channel, removing surface obstructions, and building riprap dams to contract the water-way, to remove the bar at mouth of river, and secure a navigable channel at low water to the deep waters of the Ohio.

Work was carried on during the first six months of the fiscal year, clearing away snags and other surface obstructions from Nashville to the mouth of the river, and in channel excavation and building wing-dams at several points.

The total amount expended to June 30, 1888, including outstanding liabilities, is $254,858.35, which has resulted in securing an improved channel at the most dangerous obstructions and a lengthened season of navigation.

July 1, 1887, amount available		$11,350.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,005.58	
July 1, 1888, outstanding liabilities	203.43	
		11,209.01
July 1, 1888, balance available		141.65
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,141.65

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Amount (estimated) required for completion of existing project	$83,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 7.)

Above Nashville.—This section extends from Nashville to the head of Smith's Shoals.

The work done prior to the adoption of the present project has resulted in securing an increased depth of from 6 to 8 inches over the principal obstructions, and also in giving an improved channel and lengthened season of navigation from Burnside, Ky., to Nashville, Tenn.

The present project consists of a radical improvement, by a system of locks and dams, from Nashville to head of Smith's Shoals.

The site of Lock No. 1, near Lower Nashville Island, has been determined upon, and work of lock-pit excavation and construction of lock-wall will be carried on under contract, provided the bids received are reasonable and advantageous to the Government.

From August to November, inclusive, a snagging party moved down from Burksville to Nashville, clearing the channel of snags and overhanging trees, excavating rock and gravel, and extending and repairing dams at various points.

The total amount expended under the existing project to June 30, 1888, including outstanding liabilities, is $54,424.20, and has been applied to the improving of the shoals above Nashville, and in the necessary surveys and observations and estimates pertaining to the projected work of lock construction.

July 1, 1887, amount available		$77,611.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,408.93	
July 1, 1888, outstanding liabilities	626.46	
		7,035.39
July 1, 1888, balance available		70,575.80
Amount appropriated by act of August 11, 1888		200,000.00
Amount available for fiscal year ending June 30, 1889		270,575.80

Amount (estimated) required for completion of existing project	3,753,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	400,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A 7.)

8. *South Fork of Cumberland River, Kentucky.*—This stream is an affluent of the Cumberland River, which it enters near the head of navigation, at Burnside, Ky.

An examination was made in 1881. The obstructions in the lower section from "Devil's Jumps" to the mouth, about 44 miles, are rock-reefs, gravel-bars, etc., while above the "Devil's Jumps" immense bowlders are also found in the channel, which can only be removed at great expense.

The present project provides for improving the channel of the 44 miles of river below the "Devil's Jumps" by reducing the reefs and bars, removing bowlders, and building riprap dams to contract the waterway so as to secure safe navigation at a 3-foot stage above low water.

From July to September work was carried on in the channel, reaching to a point 16 miles from mouth of the river.

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The total amount expended to June 30, 1888, was $11,968.94, which has resulted in securing an improvement of the channel for the passage of rafts and boats.

July 1, 1887, amount available		$1,877.36
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,836.33	
July 1, 1888, outstanding liabilities	9.97	
		1,846.30
July 1, 1888, balance available		31.06
Amount (estimated) required for completion of existing project		50,803.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix A A 8.)

9. *Caney Fork River, Tennessee.*—This stream flows wholly in the State of Tennessee, and is an important tributary of the Cumberland River, which it enters near Carthage, Tenn., about 120 miles above Nashville.

The river has been examined to Frank's Ferry, about 92 miles from its mouth.

The obstructions were found to be gravel-bars, snags, and overhanging trees, with a crooked channel and numerous shoals, making navigation insecure at all seasons. The present plan is to clear, deepen, and straighten the channel by removing surface obstructions, building wing-dams and training-walls, so as to secure safe navigation for rafts, flat-boats, and light-draught steamers during the boating season, usually from February to July—five months.

Active operations were carried on during the first three months of the fiscal year, clearing the channel and chutes of snags and brush, and in building wing-dams at Trousdale's Ferry, James's Shoals, and other points.

The total amount expended to June 30, 1888, including outstanding liabilities, is $19,421.95, which has resulted in obtaining a greatly improved channel as far up as Sligo Ford when the river is at a 3-foot stage above low-water mark.

July 1, 1887, amount available		$2,510.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,913.93	
July 1, 1888, outstanding liabilities	19.00	
		1,932.93
July 1, 1888, balance available		578.05
Amount appropriated by act of August 11, 1888		2,500.00
Amount available for fiscal year ending June 30, 1889		3,078.05
Amount (estimated) required for completion of existing project		22,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix A A 9.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Lieutenant Colonel Barlow was charged with and completed the following surveys, the

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results of which were transmitted to Congress and printed as House Ex. Doc. No. 84, Fiftieth Congress, first session.

1. *Obeils* [*Obeys*] *River from the point where improvements have heretofore been made to the mouth of the West Fork, Tennessee.* (See also Appendix A A 10.)

2. *Bear Creek, Mississippi* (*Big Bear Creek*), *Mississippi and Alabama.* (See also Appendix A A 11.)

IMPROVEMENT OF THE OHIO, MONONGAHELA, MUSKINGUM, AND ALLEGHENY RIVERS—OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER; LOCK AND DAM NO. 9, MONONGAHELA RIVER, AND THE LOCKS AND DAMS ON THE MUSKINGUM RIVER—CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO, AND OF LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

Officer in charge, Lieut. Col. William E. Merrill, Corps of Engineers, having under his immediate orders First Lieuts. Lansing H. Beach and Cassius E. Gillette, Corps of Engineers.

1. *Ohio River.*—The general method followed in improving the navigation of the Ohio River is to secure additional depths at islands and sand-bars by the construction of low dams closing unused passages, and by building guiding-dikes to confine the water to narrower channels. A snag-boat and two dredges, all of them having iron hulls, are owned by the United States, and find constant employment during the low-water season in taking out snags and wrecks, and in dredging away gravel-bars that can not otherwise be removed.

The first appropriation for the improvement of the Ohio River was made in 1827. The total amount thus far appropriated is $3,770,479.25. In addition to this there has been allotted to this river a portion of twenty-three different combined appropriations for the Ohio, Mississippi, Missouri, and Arkansas rivers, which aggregated $1,947,000, but the amount thus allotted is unknown.

The following is a summary of the work done during the fiscal year:

Three Brothers Islands.—The dam at this locality was repaired by relaying paving and filling a few vacant spaces.

Dike at middle of Grand Chain.—Three-fifths of this work is finished; its total length will be 3,000 feet. The contract has been extended to December 1, 1888.

Removing rocks at Grand Chain.—A blasting plant, with diver and dredge-boat, was employed by contract at the Grand Chain in removing submerged rocks, and during the fiscal year the total amount taken out of the river was 11,472 tons. The Jackson Rocks were wholly removed (except a small area not in the channel), and a marked reduction was made in the sizes of the Arkansas and Grenadier rocks.

Ice-piers.—No work on the ice-piers was done during the season, as the whole year was expended in securing proper cessions of riparian rights.

Bar at mouth of the Licking.—The contract for this work was completed and closed, resulting in the excavation of a channel 135 feet long with an average width of 65 feet. This was all that could be done with the funds available.

Great Miami Embankment.—This work consists in raising the track of the Lawrenceburgh Branch of the Cincinnati, Indianapolis, Saint Louis and Chicago Railroad, so that it will act as a levee to protect Lawrence-

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burgh from floods. The contractor is the railroad company that owns the track, and at the close of the year the work was about two-thirds done.

Dredging.—The United States dredges *Ohio* and *Oswego* worked on the Ohio River from June 18 to November 21, a period of five months, and were then transferred to the Muskingum. During this period they dredged 680 cubic yards of shale below the Davis Island Lock, 6,607 cubic yards from Wheeling Creek Bar, and 140,520 cubic yards from the channel near the Three Brothers Islands, besides doing much miscellaneous work.

Snagging.—The snag-boat *E. A. Woodruff* worked from June 17, 1887, to November 13, 1887, a period of nearly five months, during which time she removed 1,225 snags, 127 rocks, and 46 wrecks, besides doing some miscellaneous work.

Harbor of Refuge near Cincinnati.—The three dikes at Four-Mile Bar that make this harbor of refuge have been completed. Their lengths are 2,135, 2,477, and 2,500 feet, respectively.

For information relating to the stages of the Ohio River, the water-gauges established, the slope and navigability of the river, the dimensions of bridges, and losses incurred through collision with the same, as well as for a historical sketch of the improvement of the river, reference is made to the report of the officer in charge.

July 1, 1887, amount available		$198,914.37
September 12, 1887, balance of allotment for ice-harbor at mouth of Great Kanawha River transferred to Col. W. P. Craighill, Corps of Engineers	$168.44	
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	129,424.42	
July 1, 1888, outstanding liabilities	422.40	
July 1, 1888, amount covered by existing contracts	52,696.16	
		182,711.42
July 1, 1888, balance available		16,202.95
Amount appropriated by act of August 11, 1888		380,000.00
Amount available for fiscal year ending June 30, 1889		396,202.95
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		600,000.00

(See Appendix B B 1.)

2. *Operating and care of Davis Island Dam, Ohio River.*—This dam was built to test the adaptability of the system of movable dams to the peculiar conditions of the Ohio River, and to the special character of the commerce that navigates it. The dam was intended, if successful, to be the first step in the radical improvement of the Ohio, and, being the one nearest Pittsburgh, it has the incidental effect of giving this city a deep and navigable harbor at all times. Its benefit was especially evident during the prolonged drought of 1887, as there was at all times a minimum depth of 6 feet in the Monongahela Harbor.

During the fiscal year the dam was up two hundred and one days and 712 lockages were made, passing 1,871 vessels.

The operations of the lock were very satisfactory. The dam, however, did not do so well, as the defective steel cross-heads continued to give trouble, and the long continuance of low water made it almost impossible to take out wickets for repairs.

After remaining up six months the dam was lowered in the face of an ice-flood, and considerable damage ensued, partly due to the direct

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impact of fields of ice, and partly to the giving away of the defective cross-heads, which threw abnormal strains on the other members. The damages, however, were sufficiently repaired during the spring to permit the dam to be raised on June 18, and it was still standing at the close of the fiscal year.

The experience of last winter shows that some changes should be made to enable the dam to successfully encounter ice and drift. For this purpose the officer in charge recommends the removal of the Pasqueau hurters of the weirs and the substitution of Chanoine hurters with trippers. This change has been authorized. The addition of a drift-gap, for which provision is made in the last river and harbor act, will also contribute to the same end. With these two changes it is thought that there will be no further trouble.

Amount expended during the year, $16,309.01; amount required for the fiscal year ending June 30, 1889, $18,015.

(See Appendix B B 2.)

3. *Monongahela River, West Virginia and Pennsylvania.*—The object of the locks and dams which the United States is building on the Monongahela River is to extend the existing slackwater from the mouth of Dunkards Creek, Pennsylvania, to Morgantown, W. Va., a distance of 14 miles. Two locks and dams are required for this extension; No. 9, the upper, was completed in 1880; No. 8, the one next below, is in course of construction. When completed, these locks and dams will give 6 feet in low water from Morgantown to Dunkards Creek, whence there is already 4 feet to Pittsburgh, secured by seven locks and dams belonging to the Monongahela Navigation Company. The distance from Morgantown to Pittsburgh is 102 miles. At Pittsburgh the Monongahela slackwater connects with the pool of the Davis Island Dam.

The total amount heretofore appropriated for this improvement is $397,900, of which sum $348,038.03 have been expended to June 30, 1888.

Work was actively carried on during the entire season of 1887, and was resumed in the spring of 1888; during this time the masonry of the lock was completed, except a small amount of coping, and the abutment on the opposite bank of the river was about four-fifths completed.

July 1, 1887, amount available		$84,095.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$32,152.95	
July 1, 1888, outstanding liabilities	2,080.34	
		34,233.29
July 1, 1888, balance available		49,861.97
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		84,861.97

(See Appendix B B 3.)

4. *Operating and care of Lock and Dam No. 9, Monongahela River.*—During the low water of 1887 the apron below the dam, which was built in 1884, was extended across the whole width of the river, and it is believed that all danger of undermining has been removed. Minor repairs were made on other parts of the work.

The land-wall shows signs of defective construction, and it is proposed to fill it with cement grout, and to raise the chamber-walls and lower buttresses to the height of the upper buttresses, in order to make the lock available in higher stages of the river than is now the case. These repairs have been authorized.

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Amount expended during the fiscal year, $10,895.30. Amount required for year ending June 30, 1889, $6,470.

(See Appendix B B 4.)

5. *Allegheny River, Pennsylvania.*—The work hitherto done on this river has been limited to the removal of rocks, of which there was a vast number in and near the channel, and to the closure at two localities of duplicate channels. The benefit of such work has been very apparent.

The money thus far appropriated for the improvement of the river amounts to $135,000.

During the past season the dam at Corydon, Pa., was modified so as to make it safe for the passage of rafts in high water. Repairs were made on the low dams at Nicholson's Island and Six Mile Island, and 540 tons of rocks were taken out of the river.

July 1, 1887, amount available	$6,850.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,190.90
July 1, 1888, balance available	659.33
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,659.33
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

(See Appendix B B 5.)

6. *Dam at Herr's Island, Allegheny River.*—The object of this dam is to extend navigable water up the Allegheny from the head of the pool of the Davis Island Dam to the city limits, thus completing the improvement of the harbor of Pittsburgh and providing the means for the cheap transfer of freights at all seasons. This dam will also be the first step towards the radical improvement of the Allegheny River, a work that promises most valuable results.

The construction of this lock and dam has hitherto been prevented by the lack of authority to purchase the necessary land. This obstacle has lately been removed, and the work of acquiring a site is now under way. It is hoped that the work of construction may be begun in 1889. The money thus far appropriated for this work amounts to $37,500.

July 1, 1887, amount available		$37,340.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$491.55	
July 1, 1888, outstanding liabilities	256.45	
		748.00
July 1, 1888, balance available		36,592.00
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		71,592.00
Amount (estimated) required for completion of existing project		350,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix B B 6.)

7. *Ice-harbor at mouth of Muskingum River, Ohio.*—The work in hand is the construction of a lock through Dam No. 1, Muskingum River, in order to permit Ohio River craft to take refuge in ice times in Pool No. 1, Muskingum River. This lock is also needed to replace Lock No. 1 of

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the Muskingum River, which has long been in a threatening condition. The total amount thus far appropriated for this work is $237,500.

During the past working season the coffer-dam was extended, so as to include the whole of the lock, the new area thus protected was excavated to grade, the necessary piles were driven and capped, the lock-floor was completed, and about half of the new floor was covered with concrete. At this stage work was stopped on account of the exhaustion of funds.

July 1, 1887, amount available	$27,851.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	26,689.27
July 1, 1888, balance available	1,162.46
Amount appropriated by act of August 11, 1888	60,000.00
Amount available for fiscal year ending June 30, 1889	61,162.46

(See Appendix B B 7.)

8. *Muskingum River, Ohio.*—The act of August 5, 1836, appropriated $20,000 for this river, which was expended in repairing the locks and dams. In obedience to the instructions of the Secretary of War, estimates were prepared by Lieut. Col. W. E. Merrill, Corps of Engineers, of the entire cost of completing the repairs of the locks and dams in the Muskingum River, and his report was transmitted to Congress by the Secretary of War January 18, 1888, and printed as House Ex. Doc. No. 108, Fiftieth Congress, first session.

The estimated cost of repairing all of the locks and dams was $268,128, and of getting rid of the Taylorsville Canal and one lock $102,000.

The latter sum is appropriated by the river and harbor act of August 11, 1888.

9. *Operating and care of the locks and dams on the Muskingum River, Ohio.*—As originally improved by the State of Ohio, the Muskingum River contained eleven dams and twelve locks, and furnished continuous navigation for 91 miles from the Ohio River at Marietta to Dresden, where a connection was made with the Ohio Canal, running from the Ohio River at Portsmouth to Lake Erie at Cleveland. The locks are 180 feet long and 36 feet in the clear, with lifts varying from 8 feet 10 inches to 12 feet 1 inch. On the 75 miles of slackwater now existing, which terminates at Zanesville, there are 10 dams, 11 locks, and 5 lateral canals, the total length of the latter being 3⅔ miles. The original cost of the works was about $1,500,000.

The United States accepted these works from the State of Ohio on the 7th of April, 1887, and found them in a state of extreme dilapidation. The lock and dam at Symmes Creek, 10 miles above Zanesville, had been abandoned, two of the other dams were broken, and the walls of one lock were on the verge of falling down. Energetic work, aided by a very favorable season, resulted in the repair of the broken dams and the threatening lock; such other repairs were made as were most necessary, and as a result the works passed through the ice and flood of last winter without injury. Heavy repairs were made on five dams and four locks. A contract was made for a ladder dredge-boat.

The most important work now needed is to repair the locks at Stockport, McConnellsville, and Eagleport, all of which are in a dangerous condition; to build a new lock at Taylorsville, thus permitting the abandonment of the canal at that place, to turn two lifts into one at

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Zanesville, and to rebuild lock and Dam No. 11, thus restoring connection with the Ohio Canal.

July 1, 1887, amount available		$4,896.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		4,896.92
Amount expended during the fiscal year:		
From appropriation of August 5, 1886	$4,896.92	
From indefinite appropriation	179,006.21	
		183,903.13
Amount for year ending June 30, 1889		177,623.00

(See Appendix B B 8.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Lieutenant-Colonel Merrill was charged with and completed the following survey and examination, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 88, Fiftieth Congress, first session:

1. *Ohio River near the city of Evansville, Indiana, to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.*—(See also Appendix B B 9.)

2. *Big Hockhocking River from its mouth to Coolville, Ohio.*—(See also Appendix B B 10.)

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, OF WHITE RIVER, INDIANA, AND OF TRADEWATER RIVER, KENTUCKY.

Officer in charge, Maj. Amos Stickney, Corps of Engineers, having under his immediate orders Lieut. E. J. Spencer, Corps of Engineers, until August 19, 1887; and Lieut. W. L. Sibert, Corps of Engineers, from July 11, 1887, to April 11, 1888.

1. *Falls of the Ohio, Louisville, Kentucky.*—By the river and harbor act approved August 5, 1886, this work, which at first consisted of the enlargement of the upper portion of the Louisville and Portland Canal, was made to include the enlargement of the basin of the canal just above the locks.

Enlargement of upper portion of Louisville and Portland Canal.—The present project was adopted in 1883, with the object of enlarging the upper end of the Louisville and Portland Canal, from a point about 400 feet below the railroad bridge to the upper end of the reef which extends to a point about opposite Fourth street, which practically makes a wide harbor from Fourth to Tenth streets, and more than doubles the width of the canal from Tenth to Fifteenth street. The amount expended to June 30, 1888, was $245,544.42.

The work was done under four contracts, three for excavating and moving materials, and one for the construction of a new canal wall along the northern line of the improvement. One of the contracts for excavation was completed in November, 1886.

On the middle section the earth, loose rock, and old wall have been removed, and about 77 per cent. of the rock excavation completed. On

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the upper section about 32 per cent. of the rock excavation has been completed to grade.

About one-half of the new canal wall is completed. Work was begun about the 1st of June, and continued until the 1st of December.

Under the contracts for excavation of material about 104,116 cubic yards remain to be removed.

Enlarging basin of canal.—On this work the contractors have excavated 108,795 cubic yards of earth, and 3,575 cubic yards of rock. The amount expended to June 30, 1888, was $25,415.98.

July 1, 1887, amount available		$280,922.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$103,189.71	
July 1, 1888, outstanding liabilities	19,236.94	
July 1, 1888, amount covered by existing contracts	140,048.41	
		262,475.06
July 1, 1888, balance available		18,447.05
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		168,447.05
Amount (estimated) required for completion of existing project, including enlargement of canal basin		855,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		370,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C C 1.)

2. *Indiana Chute, Falls of the Ohio River.*—The present project is to remove projecting points and reefs in the Indiana Chute, to make an unobstructed channel, 400 feet in width, between the dam and railroad bridge. The original chute was crooked, full of projecting rocks, and very difficult to navigate. The work of the past season was devoted principally to the left-hand reef, the high points on which were entirely removed for a distance of about 1,200 feet.

Isolated points in the channel and on the right-hand reef were also removed. Work was vigorously prosecuted from September 27, to November 21. The dam at the head of the Falls and the guiding-dike north of the canal were thoroughly repaired.

The amount expended to June 30, 1888, was $115,576.06.

July 1, 1887, amount available		$19,773.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,350.02	
July 1, 1888, outstanding liabilities	11.50	
		10,361.52
July 1, 1888, balance available		9,412,44
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		24,412.44
Amount (estimated) required for completion of existing project		115,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix C C 2.)

3. *Operating and care of Louisville and Portland Canal.*—During the fiscal year the canal was open for the passage of commerce three hundred and forty-five days, having been closed eighteen days on account of high water and two days by ice. The old locks were used to pass one boat. During the year 5,471 vessels, representing an undertonnage of 1,315,851 tons, were passed through the canal.

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Necessary repairs have been made to lock machinery and operating plant.

The shops and store-houses which were moved on account of the enenlargement of the basin above the locks are in place, with the exception of one warehouse.

The tow-boat was docked, and new hog-chains put on her. Proposals have been received for paving the lower part of the high earth slopes at the locks to prevent slides during high water. The old tow-boat *Walker Morris* was sold at public auction. It is proposed during the coming year to keep the canal in operation, build new guard-gates for both the old and new locks, and to excavate a channel below the new locks over a length of 300 feet and 100 feet wide at a cost of $19,200. It is also proposed to extend the pipes of the city water-works to the locks to supply water for the use of the employés.

The total receipts from all sources amount to $2,494.61.

The estimated amount required for operating and maintaining the canal during 1888–'89 is $100,105.

July 1, 1887, amount available		$34,863.97
Allotment, year ending June 30, 1888		77,805.00
		112,668.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$48,809.25	
July 1, 1888, outstanding liabilities	4,646.51	
July 1, 1888, dropped, not drawn	58,565.00	
		112,020.76
July 1, 1888, balance available		648.21

(See Appendix C C 3.)

4. *Wabash River, Indiana and Illinois.*—The first appropriation for the improvement of this river was made in 1872. The project contemplated the construction of a lock and dam at Grand Rapids near Mount Carmel, and the removal of rock ledges, sand-bars, snags, and other obstructions, and the closing of chutes, with a view to obtaining a navigable channel of 3½ feet in depth from the mouth of the river to Vincennes.

The river has been separated into two portions in reference to its improvement, with Vincennes, Ind., as the dividing point, and appropriations have been made for each division.

Below Vincennes.—The principal work on this division of the river was the procuring of stone and the building of masonry on the lock at Grand Rapids. The site of the old lock was excavated and 695 cubic yards of masonry laid in the new lock. The levee at Grayville was repaired and extended 250 feet. Repairs on the snag-boat were completed and she is nearly ready for work during the coming season. A new hull was built for the dredge and the machinery transferred.

The amount expended on this portion of the river to June 30, 1888, was $155,959.38.

July 1, 1887, amount available		$46,436.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$22,645.58	
July 1, 1888, outstanding liabilities	3,726.06	
July 1, 1888, amount covered by existing contracts	10,365.77	
		36,737.41
July 1, 1888, balance available		9,698.90
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		69,698.90

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Amount (estimated) required for completion of existing project	$190,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	90,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C C 4.)

Above Vincennes.—The project for the improvement for this part of the river was the removal of obstructions and the construction of wing-dams when necessary. No work was done on this portion of the river during the fiscal year ending June 30, 1888, there being no funds available.

The accumulation of snags and the formation of a new cut-off about 20 miles above Vincennes have made navigation very difficult.

The amount expended on this river above Vincennes to June 30, 1888, was $65,929.92.

July 1, 1887, amount available	$70.08
July 1, 1888, outstanding liabilities	10.05
July 1, 1888, balance available	60.03
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,060.03

Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C C 4.)

5. *White River, Indiana.*—The present project for the improvement of this river extends from the mouth to the railroad bridge at Hazleton, and contemplates the obtaining of a depth of 3½ feet at low water. This is to be accomplished by a cut through the rock at Kelly's Ripple by dikes, dredging, and by the removal of snags. The bad location of the draw in the railroad bridge at Hazleton precludes the advisability of any improvement above that point for the present.

The work of the past year has been confined to dredging loose rock from the previously blasted channel at Kelly's Ripple. About 5,190 cubic yards of rock were removed from this channel. A new hull for the dredge was built, and the machinery transferred in April and May, 1888.

Amount expended to June 30, 1888, was $99,764.05.

July 1, 1887, amount available		$4,940.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,226.04	
July 1, 1888, outstanding liabilities	366.19	
		2,592.23
July 1, 1888, balance available		2,348.26
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,348.26

Amount (estimated) required for completion of existing project	12,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix C C 5.)

6. *Tradewater River, Kentucky.*—This river is a tributary of the Ohio and empties into it 79 miles below Evansville, Indiana.

The present project, adopted in 1881, contemplates the formation of

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a clear channel at least 40 feet wide, with a minimum depth of 2½ feet during eight months of the year for a distance of 41 miles.

The work of the past year consisted in the removal of a number of snags, tree-tops, etc., from the first 19 miles of the river. The work was limited by the small amount of funds available, viz, about $550.

The river is in good condition for a distance of about 24 miles from its mouth, but a few snags remain to be removed from this part.

Amount expended to June 30, 1888, $10,110.46.

July 1, 1887, amount available		$549.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$160.12	
July 1, 1888, outstanding liabilities	18.00	
		178.12
July 1, 1888, balance available		371.54
Amount appropriated by act of August 11, 1888		6,000.00
Amount available for fiscal year ending June 30, 1889		6,371.54

(See Appendix C C 6.)

IMPROVEMENT OF GREAT KANAWHA AND ELK RIVERS, AND CONSTRUCTION OF HARBOR OF REFUGE AT MOUTH OF GREAT KANAWHA RIVER, WEST VIRGINIA; IMPROVEMENT OF NEW RIVER IN VIRGINIA AND WEST VIRGINIA.

Officer in charge, Col. William P. Craighill, Corps of Engineers.

1. *Great Kanawha River, West Virginia.*—This river flows through a fertile and picturesque region, filled with mineral wealth, especially coal and salt. It was by nature divided into a number of pools, some of considerable length and depth, separated by shoals of gravel and coarse sand, which were the principal obstructions to navigation in low water, there being often on them at such seasons but a few inches of water. In some of the pools were found shallow places, also obstructing navigation. There were also snags and loose rocks in the channel. The navigation above Charleston was more obstructed than below. Above it was almost suspended in summer.

The coal and salt were generally sent out on rises, which enabled the boats to pass safely over the obstructions that otherwise would stop their movements entirely. The use of the river for the movement of these valuable products was therefore unsatisfactory and intermittent. By the agency and superintendence of a Board acting under the State, first of Virginia and then of West Virginia, considerable improvement in the river was from time to time effected, tolls being charged on the commerce for payment of expenses.

The object of the improvement begun several years ago by the United States was to give a constant navigable depth of at least 6 feet throughout the whole length of the Kanawha to its mouth at the Ohio River, to be accomplished by large locks and dams. Those already built have been about 300 by 50 feet.

The peculiarity of most of the dams is that they can be lowered when the stage of water in the river will suffice over the shoals. This gives them the name of "movable dams," and enables an open river to be had where the water is high enough.

Dams 3 and 2, both above Paint Creek, are fixed, as the declivity of the river in that section is too great to permit the advantageous use of the movable system.

Up to June 30, 1887, the amount expended was $1,844,817.86. At that date Lock and Dam 3, 21 miles above Charleston Ferry, had been

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completed, as also Locks and Dams 4 and 5, respectively, 15 and 9 miles above.

The amount expended in the year ending June 30, 1888, exclusive of outstanding liabilities, was $96,432.19, applied at sites 2 and 6.

Lock and Dam 6 were put in operation October 11, 1886. Lock 2 was completed in the autumn of 1887 and the dam in December, 1887.

Site 7 has been for several years owned by the United States, but work could not be begun because funds were not available.

Had funds been available, all the locks and dams needed for this important improvement could have been begun at the same time and finished in three years, with much economy to the United States and with manifest advantage in the use of the improved water-way.

The development of commerce on this river has been very great since its improvement by the United States, although the project has been only partially executed for want of money.

A law was enacted by Congress March 3, 1887, prescribing the terms under which bridges might be erected over the Great Kanawha River. Taking advantage of this, the company which is building a railroad along the left bank of the Ohio has completed a bridge over the Kanawha at its mouth.

By an act of February 28, 1887, authority was also granted to the Kanawha and Ohio Railroad Company to lay its track through the United States lock and dam property on the Great Kanawha River, under such restrictions as the Secretary of War should prescribe.

The completion of Lock and Dam 2 in 1887 was a most important extension of the improvement, as it enabled the pool thus formed to be used for the shipment of coal in a section containing most extensive and valuable mines which have hitherto been dependent entirely on the railroads for reaching a market.

During the long continued season of low water in 1887 the value of the improvement was shown in a very marked manner, as free and sufficient navigation was maintained through it over the improved part of the river, while navigation was entirely suspended below the lowest dam and above the upper pool.

July 1, 1887, amount available	$102,327.81
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	96,432.19
July 1, 1888, balance available	5,895.62
Amount appropriated by act of August 11, 1888	350,000.00
Amount available for fiscal year ending June 30, 1889	355,895.62
Amount (estimated) required for completion of existing project	1,320,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix D D 1.)

2. *Operating and care of the locks and dams on the Great Kanawha River, West Virginia.*—Amount expended during the fiscal year ending June 30, 1888, $14,417.62.

(See Appendix D D 2.)

3. *Harbor of Refuge at mouth of Great Kanawha River, West Virginia.*—In charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until September 12, 1887. This work consists of three ice-piers in the Great Kanawha River, about 1 mile above its mouth. The piers were built in order to protect water-craft from ice-floes coming down the Great

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Kanawha River. Two of the piers are on the right bank, at distances of 4,200 and 6,300 feet, respectively, from the mouth of the river, and one on the left bank at a distance of 6,600 feet. They are rectangular in plan, and are built to a height of 29½ feet above low water.

The work contemplated having been completed no additional funds are required.

July 1, 1887, amount available	$168.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	168.44

(See Appendix D D 3.)

4. *Elk River, West Virginia.*—The country through which this stream flows is rich in minerals and well fitted for agriculture and grazing. The approved project of improvement has been the removal of rocks, snags, overhanging trees, etc., and the cutting of narrow sluices through the rapids and shoals. The principal interests to be served are those of lumbering and rafting, but much country produce is also carried down stream in small boats, which return with merchandise, etc.

The cost of the improvement was originally estimated at $100,000 to make it complete of its kind. The first appropriation was in June, 1878. The total expenditure prior to June 30, 1886, was $17,000. The work done up to that time was of great benefit to the comparatively undeveloped section through which the river flows.

The law of August, 1886, contained an item of $1,500 for this stream, but the season was too far advanced for the resumption of work with advantage and economy, which can only be done at low water.

The available money was not spent in the fiscal year just closed, as it was deemed better to hold so small a sum in the hope of its increase by another appropriation, with both of which together work can be done much more economically.

July 1, 1887, amount available	$1,500.00
July 1, 1888, balance available	1,500.00
Amount appropriated by act of August 11, 1888	3,000.00
Amount available for fiscal year ending June 30, 1889	4,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

(See Appendix D D 4.)

5. *Gauley River, West Virginia.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination was made of the Gauley River, no detailed survey being needed. A report of the results of the examination was transmitted to Congress January 21, 1888, and printed as House Ex. Doc. No. 114, Fiftieth Congress, first session.

It is proposed to improve this river from its mouth up to the Roughs, a distance of 12 miles, by straightening the channel and removing obstructions, at an estimated cost of $10,000.

The river and harbor act of August 11, 1888, contains an appropriation of $3,000 for improving the river, and a further sum of $7,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$3,000.00
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,000.00

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6. *New River, from the mouth of Wilson, in Grayson County, Virginia, to the mouth of Greenbrier River, West Virginia.*—The appropriations have been made in such manner as to divide this portion of the river into three sections, as follows:

	Miles.
Upper, or Lead Mines	62
Middle, or New River Bridge	43
Lower, or Greenbrier	86½

Throughout this distance the navigable channel consisted of natural chutes through the ledges and shoals of varying widths, rarely over 1 foot in depth, in some places so tortuous as to render navigation extremely difficult and dangerous.

The original project adopted for the improvement of these natural channels was to widen them to 30 or 50 feet, as might be required, deepen them to 2 feet, and straighten such as needed it. This was for bateau navigation; the improvement, however, to be made in such a manner as to aid the work should a greater depth and width be required in the future.

A small steam-boat, draught 12 inches when light, having been built at Hinton, in the fall of 1878, rendered it necessary to make the channel in that section 50 feet wide at all points, and in many from 75 feet to 100 feet, the depth of 2 feet being retained. This steam-boat was not adapted in dimensions and power to the navigation of the river, and was withdrawn.

The original plan of improvement has been adhered to, except that the width of channels on the middle and upper divisions has been reduced to 20 feet, and on the former to 10 feet for several miles, to allow iron to be shipped from the furnaces above.

There was no appropriation for this river in 1883, 1884, or 1885. July 1, 1886, there was a balance remaining unexpended of $3,000 from the appropriation of August 2, 1882. This pertained by special designation of the law to the portion of the river above Foster's Falls, which are not passable. The balance remained unexpended because of the impassability of these falls. As the disconnection with routes of transportation caused by these falls would practically disappear on the completion of the railroad up Cripple Creek, and as boats could then ship to the railroad their freight at Porter's Ferry, above the lead mines and the falls, it was concluded to improve the condition of Williamson's Ledges and Shoals. This work was continued as late as the season allowed, a small balance of funds being left unexpended, but not large enough to justify the resumption of operations in the summer of 1886.

The navigation of the river not being continuous as yet, it is practically a feeder to the railroads which cross it and run along portions of it. It has also been of much use in carrying materials and supplies to the railroads while in process of construction near it. It is probable that when the river is fully improved boats will transport one-third of the products of the fine agricultural country through which it flows, and seven-eighths of those of the mines, exclusive of coal.

There was an appropriation of $10,000 in the law of August 5, 1886, applicable only to the portion of the river above the lead mines. When the money became available it was too late to commence operations in 1886. For more than one reason it seemed inexpedient to spend this appropriation in the year ending June 30, 1888. The portion of the river to which it is applicable is above Foster's Falls, and these can only be passed by one or two locks at a cost much greater than Congress is likely to authorize. There is also strong reason for doubt whether, con-

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sidering the present development of that section of the country, the construction of such locks would be justifiable even if the money were available. The construction of railroads near this stream has for the present diminished very much the importance of the improvement of the portion above Foster's Falls. After a careful re-examination of the subject, and a reconnoissance of the river and its vicinity, it was decided to postpone the expenditure of the appropriation until the will of Congress could be further ascertained.

July 1, 1887, amount available	$10,222.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	75.00
July 1, 1888, balance available	10,147.29
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

(See Appendix D D 5.)

EXAMINATIONS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

The required preliminary examinations of the following streams were made by the local engineer, Colonel Craighill, and reported by him as worthy of improvement to a limited extent, but no additional surveys required:

1. *Gauley River, West Virginia.*—(See Appendix D D 6.)
2. *Meadow River, West Virginia.*—(See Appendix D D 6.)

The results of these examinations were transmitted to Congress at its last session and printed as House Ex. Doc. No. 114, Fiftieth Congress, first session.

IMPROVEMENT OF KENTUCKY AND LICKING RIVERS; OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON THE KENTUCKY RIVER, KENTUCKY; IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY; AND OF GUYANDOTTE, LITTLE KANAWHA, AND BUCKHANNON RIVERS, WEST VIRGINIA.

Officer in charge, Capt. D. W. Lockwood, Corps of Engineers, having under his immediate orders Lieut. W. L. Sibert, Corps of Engineers, since April 11, 1888.

1. *Kentucky River, Kentucky.*—This river was in temporary charge of Maj. Amos Stickney, Corps of Engineers, until April 17, 1888. The present project for the improvement of this river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky, and extend slackwater navigation for a draught of 6 feet, by the construction of additional locks and dams, to Beattyville, a distance of 261 miles from the mouth of the river.

During previous years the five original locks have been repaired and three of the dams rebuilt, the fourth and fifth having also been restored to a serviceable condition. Contracts have been entered into for the stone for Lock No. 6, and the contractors are at work.

The dam at Beattyville was cut down by removing the crest and two upper steps, so as not to interfere with free navigation at the proper stage of water, and the material taken out used in bank protection or stored for future use. A stone quarry has been opened up 4 miles from the dam, and stone is being taken out to construct the new lock at

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Beattyville. Stone is also being taken out for the new lock at No. 6, but the contractors are making slow progress.

July 1, 1887, amount available		$158,367.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$54,622.66	
July 1, 1888, outstanding liabilities	7,623.90	
July 1, 1888, amount covered by existing contracts	71,536.55	
		133,783.11
July 1, 1888, balance available		24,584.26
Amount appropriated by act of August 11, 1888		180,000.00
Amount available for fiscal year ending June 30, 1889		204,584.26
Amount (estimated) required for completion of existing project		1,854,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		400,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E E 1.)

2. *Operating and keeping in repair locks and dams on the Kentucky River, Kentucky.*—In temporary charge of Maj. Amos Stickney, Corps of Engineers, until April 17, 1888.

There is at present slackwater navigation upon the Kentucky River for a distance of 99 miles. During the year extensive repairs were made at most of the locks and additional works such as guide-walls, bank protection walls, etc., built. The lock entrances were dredged where necessary, and banks paved about the locks. One lock-keeper's house was built and general repairs made to others where necessary. The locks have been operated and continuous navigation maintained, with the exception of times when the locks were closed for repairs and a few days when ice interfered.

The amount estimated for operating and maintaining navigation for year ending June 30, 1889, is $82,769.50. It is proposed to complete the auxiliary works, rebuild one abutment, and make such general repairs as may be necessary.

(See Appendix E E 2.)

3. *Licking River, Kentucky, from Farmer's to West Liberty.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination of the Licking River between the points above indicated was made (a survey being unnecessary), and the report thereon is printed in the Report of the Chief of Engineers for 1887 as Appendix D D 12 (page 1902).

The proposed improvement contemplates the removal of snags and rocks obstructing the channel, at an estimated cost of $17,680.

The river and harbor act of August 11, 1888, appropriates $3,000 for the work, and a further sum of $5,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$3,000.00
Amount (estimated) required for completion of existing project	14,680.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

4. *Big Sandy River, West Virginia and Kentucky.*—In temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until April 13, 1888.

The present approved project for the improvement of this river contemplates the construction of a lock and dam at Louisa, below the junc-

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tion of the two forks, and also the improvement of open river navigation on these forks and on the main river. The object of building the dam is to form a pool for holding coal boats and barges, with a view to the shipment of coal from the extensive deposits found in the valley. It is expected that other locks and dams will be built if this experimental one should prove a success. For open river navigation on the fork it is intended to secure a channel with a minimum depth of 1 foot and a minimum width of 50 feet during six months in the year.

During the past year the abutment of the proposed dam at Louisa was completed and the river below the lock cleared of some of the worst obstructions. Above the dam the Tug and Levisa Forks were cleared of obstructions and chutes improved, as far as the funds on hand would permit.

July 1, 1887, amount available	$10,888.01
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,425.63
July 1, 1888, balance available	3,462.38
Amount appropriated by act of August 11, 1888	31,500.00
Amount available for fiscal year ending June 30, 1889	34,962.38
Amount (estimated) required for completion of existing project	31,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	31,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E E 3.)

5. *Guyandotte River, West Virginia.*—In temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until April 13, 1888.

The object of work on this river is to remove rocks and logs and other obstructions, so as to make a smooth channel for rafts and push-boats during the season of good water, there being no navigation at all during low water. The channel to be cleared out will be 122 miles long, and it is designed to give it a minimum width of 30 feet and minimum depth of 18 inches during five months in the year.

No work was done during the past year from lack of funds.

Amount appropriated by act of August 11, 1888	$2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix E E 4.)

6. *Little Kanawha River, West Virginia.*—In temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until April 13, 1888.

The approved project for the improvement of this river contemplates the construction of a lock and dam to extend slackwater for a draught of 4 feet a distance of 12 miles, and the improvement of the natural channel of the upper river by the removal of obstructions for a distance of 80 miles, the object of the last-named work being to obtain a channel of a minimum width of 40 feet, containing at least 2 feet of water during four months of the year. The navigation of the river above the slackwater is by push-boats and rafts.

During the past year the stone needed to complete the lock was quarried by hired labor, transported to the lock site, and part of it cut for the lock-walls.

Owing to lack of funds, work for the benefit of open river navigation was confined to repairing the chute at Glenville.

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July 1, 1887, amount available		$7,784.93
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,420.66	
July 1, 1888, outstanding liabilities	30.00	
		7,450.66
July 1, 1888, balance available		334.27
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,334.27
Amount (estimated) required for completion of existing project		26,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		26,800.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1836 and 1867.		

(See Appendix E E 5.)

7. *Buckhannon River, West Virginia.*—In temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers, until April 13, 1888.

This is a tributary of the Tygerts Valley River, which itself is one of the tributaries of the Monongahela. The improvement of this river contemplates the formation of a rafting channel between the Three Forks and the town of Buckhannon, a distance of 24½ miles. The proposed channel will have a minimum width of 30 feet and a minimum depth of 2 feet during four months of each year.

No work done during the past year from lack of funds.

July 1, 1887, amount available		$3.68
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		3.68
Amount appropriated by act of August 11, 1888		1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix E E 6.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Lieutenant-Colonel Merrill was charged with and completed the survey of the *Louisa (Levisa) Fork of Sandy River, Virginia*, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 88, Fiftieth Congress, first session. (See also Appendix E E 7.)

Major Stickney was charged with and completed the survey of *Salt River, Kentucky*, the results of which were transmitted to Congress and printed in House Ex. Doc. No. 184, Fiftieth Congress, first session. (See also Appendix E E 8.)

LAKE HARBORS AND RIVERS.

IMPROVEMENT OF THE HARBORS AT DULUTH, MINNESOTA, AND AT SUPERIOR BAY AND SAINT LOUIS BAY, WISCONSIN—IMPROVEMENT OF THE HARBORS AT GRAND MARAIS AND AGATE BAY, MINNESOTA.

Officer in charge, Capt. James B. Quinn, Corps of Engineers.

1. *Harbor at Duluth, Minnesota.*—The original project for the improvement of the harbor, adopted in 1871, consisted of a breakwater in

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Lake Superior, outside of Minnesota Point, in continuation of a breakwater already commenced by the Northern Pacific Railroad Company. This breakwater was destroyed by a storm in 1872 and abandoned. In 1873 Congress provided for maintaining the canal through Minnesota Point, which had been constructed by the city of Duluth, and for dredging channels in Superior Bay to the Duluth docks.

Work under this project was continued until 1881, at which time the piers of the canal had been repaired and somewhat extended, a harbor basin dredged of moderate capacity, and a narrow channel dredged in Superior Bay from Duluth to deep water at Connor's Point. The amount expended under this project was $270,651.81.

The present project was adopted in 1881 and modified in 1884, the object being to preserve the piers bordering the canal and in dredging an inner harbor and channels to accommodate vessels drawing 16 feet of water.

The amount expended under present project to June 30, 1888, was $197,848.25, and has resulted in increasing the dredged area of basin to about 104 acres, exclusive of private dredging, a gain of 20 acres during past fiscal year, and removing shoals from area previously dredged, giving the whole dredged basin a minimum depth of 16 feet, deepening the Blast Furnace Channel to a like depth, and in maintaining the canal piers.

Work during the past fiscal year consisted in repairing the entrance piers and deepening and enlarging the main harbor basin to the southward. The amount of material excavated was 159,940.35 cubic yards.

The piers are in fairly good condition, but the superstructure, and perhaps the entire work, will eventually require to be replaced with more durable material. The ruling depths in the portions of the harbor dredged by the United States are:

	Feet.
In canal	16
In the inner basin or harbor	16
In Blast Furnace Channel to a point opposite Elevator E	16
From point opposite Elevator E, through dredged channel along east side of Rice's Point to the Saint Louis River	12

All the areas and channels above mentioned (canal and anchorage area excepted) require widening.

Since 1881 the narrow channel which was dredged from Duluth to deep water at Connor's Point has shoaled so that it now has a minimum or ruling depth of 12 feet, and large vessels can only pass through light. The advance of the Rice's Point dock line absorbs this channel, and the new channel parallel with the new dock line becomes necessary to preserve this line of communication.

July 1, 1887, amount available	$42,415.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	38,615.92
July 1, 1888, balance available	3,799.14
Amount appropriated by act of August 11, 1888	80,000.00
Amount available for fiscal year ending June 30, 1889	83,799.14
Amount (estimated) required for completion of existing project	39,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	39,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F F 1.)

2. *Harbor at Superior Bay and St. Louis Bay, Wisconsin.*—Originally a sand-bar obstructed the natural entrance to Superior Bay, with a

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narrow and tortuous channel through it, having a minimum depth of 9 feet. In Superior Bay a deep natural channel, having a depth of not less than 14 feet and a width of from 100 to 500 feet, extended from the natural entry to Connor's Point. Nine feet was the greatest draught that could reach the docks at Superior, one-half mile distant from the natural channel.

The original project, adopted in 1867 and modified in 1873, comprised the construction of parallel piers 350 feet apart, and dredging between the piers; dredging in Superior Bay from natural channel to Quebec Wharf; maintenance of piers and protecting portions of Minnesota Point where the sea threatened to break through. The amount expended on original project was $335,513.26.

The present project was adopted in 1881 and modified in 1884, which added improvement of St. Louis River channel within the bay of Superior, the object being to provide channels for vessels drawing 16 feet of water. The act of August 5, 1886, added the improvement of St. Louis Bay.

The natural and dredged channels in 1881 were about 100 feet wide, with not more than 11 feet in depth at the shoalest part.

The amount expended under present project to June 30, 1888, was $115,100.21, and resulted in securing channels having a minimum width of 100 feet and not less than 16 feet in depth.

Work during the past year consisted in dredging, the amount of material removed being as follows:

	Cubic yards.
Dredging in St. Louis Bay along the dock-line on the Wisconsin shore, between Connor's Point and Grassy Point	12,829
Deepening and enlarging channels in Superior Bay and harbor, including the mouth of the Nemadji River	19,644
Total	32,473

The entry piers are in fair condition, but need extensive repairs, particularly the superstructure, to render them secure. The beach protection is still intact.

The following are ruling depths in the channels dredged by the United States:

	Feet.
From Connor's Point to the entry	16
From Northern Pacific Railroad Dock to the entry	10
In front of Quebec Dock	16
Throughout the entry between piers	16

July 1, 1887, amount available	$18,768.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,497.78
July 1, 1888, balance available	10,270.33
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	60,270.33

Amount (estimated) required for completion of existing project	177,580.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix F F 2.)

3. *Harbor at Agate Bay, Minnesota.*—This harbor, on the north shore of Lake Superior, 27 miles from Duluth, is a shipping port for iron ore. It also serves the purpose of a harbor of refuge. Its naturally deep water renders but little dredging necessary in order for vessels to reach the docks.

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The present project for improvement of this harbor, adopted in 1887, consists in the construction of two breakwater piers, extending from the eastern and western points of the bay, to be 1,000 and 900 feet long, respectively, and on a line towards each other, leaving an opening of 1,340 feet between the outer extremities and inclosing an area of 109 acres.

The amount expended thereon to June 30, 1888, was $20,682.94, and has resulted in the construction of 400 linear feet of the east breakwater, giving very material protection to vessels lying at Merchandise Dock from southerly storms. The appropriation asked is to be applied to the completion of the east 1,000 feet of breakwater.

July 1, 1887, amount available	$21,521.47
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,704.41
July 1, 1888, balance available	1,817.06
Amount appropriated by act August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,817.06
Amount (estimated) required for completion of existing project	175,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	

(See Appendix F F 3.)

4. *Harbor at Grand Marais, Minnesota.*—This was originally a natural harbor basin, but of insufficient depth for large vessels, and not wholly protected from storms. The need of a harbor of refuge somewhere in this locality was felt on account of the long stretch of coast-line between existing available harbors, and led to the project for the improvement of this harbor for that purpose.

The present project for its improvement, adopted in 1879, consisted of deepening the basin to 16 feet and constructing a breakwater out from Mayhew's Point so as to partially close the natural opening and lessen the exposure to storms.

The amount expended to the close of the fiscal year ending June 30, 1888, was $77,577.77, and has resulted in obtaining a dredged basin having an area of 11 acres, with a minimum depth of 16 feet, a gain of one acre during fiscal year, and the construction of 350 linear feet of breakwater. The harbor is now accessible for vessels of the largest size and draught that come to Lake Superior, but the smallness of the dredged basin limits its accommodation to but very few vessels at one time, and hampers their movements when in the harbor.

The breakwater is already of much service for the protection of shipping.

July 1, 1887, amount available	$5,643.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,220.96
July 1, 1888, balance available	2,422.23
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	17,422.23
Amount (estimated) required for completion of existing project	44,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	44,700.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix F F 4.)

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HARBORS ON LAKE SUPERIOR (EAST OF SUPERIOR CITY), ON GREEN BAY AND ON THE WESTERN SHORE OF LAKE MICHIGAN, NORTH OF MILWAUKEE, WISCONSIN.

Officer in charge, Maj. Charles E. L. B. Davis, Corps of Engineers.

1. *Ashland Harbor, Wisconsin.*—The project for the improvement of this harbor was adopted in 1887, and modified in 1888, and has for its object the construction of a breakwater northeast of the town to be about 8,000 feet long for the protection of the shipping at the wharves, and to dredge a channel in front of the city wharves sufficient for vessels of 16-feet draught.

No work has been done, as the amount available during the fiscal year was insufficient to commence a work of such magnitude.

July 1, 1887, amount available	$21,820.43
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	827.40
July 1, 1888, balance available	20,993.03
Amount appropriated by act of August 11, 1888	60,000.00
Amount available for fiscal year ending June 30, 1889	80,993.03
Amount (estimated) required for completion of existing project	90,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 1.)

2. *Ontonagon Harbor, Michigan.*—The present project for the improvement of this harbor was adopted in 1867, the object being to afford an entrance to the mouth of the Ontonagon River, not less than 12 feet deep, and of a navigable width. This result was to be accomplished by constructing two parallel piers, 250 feet apart, from the river's mouth lakeward to the 18-foot contour in Lake Superior, and dredging a channel between them 12 feet in depth.

The natural channel was but 7 feet in depth, and owing to the shifting nature of the bottom was variable in position.

The amount expended to June 30, 1888, is $284,029.52, and has resulted in the construction of 2,315 feet of east and 2,525 feet of west pier, and the removal of 10,546 yards of sand, making a channel 100 feet wide and 13 feet deep between the piers with a depth of 12.1 feet on the outer bar.

July 1, 1887, amount available	$14,747.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	13,205.07
July 1, 1888, balance available	1,541.98
Amount appropriated by act of August 11, 1888	12,500.00
Amount available for fiscal year ending June 30, 1889	14,041.98
Amount (estimated) required for completion of existing project	65,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 2.)

3. *Eagle Harbor, Michigan.*—The project for the improvement of this harbor was adopted in 1866, and modified in 1868, 1874, and 1878. Previous to the improvement, the entrance was obstructed by a rocky reef with 8½ feet of water over the shoalest point.

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The plan as finally carried out consisted in blasting and dredging through the rocky ledge a channel 130 feet wide and 14 feet deep, and marking it by two guiding-cribs, one on each side of the channel, and the removal of a number of bowlders.

The amount expended to June 30, 1888, is $94,513.67, and has resulted in carrying out the above plan, the work being completed in 1885 and meeting the present demands of commerce.

No appropriation is asked for for this harbor, as the funds on hand will probably be sufficient to cover the expenses of keeping the channel and cribs in good condition for several years.

July 1, 1887, amount available	$2,886.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.00
July 1, 1888, balance available	2,486.33

(See Appendix G G 3.)

4. *Establishment and maintenance of harbor lines in Portage Lake, Michigan.*—Congress by act of August 5, 1886, conferred upon the Secretary of War the authority to establish harbor-lines where débris of mines or stamp works were liable to work injury to navigation. Harbor lines were accordingly established in Portage Lake, Michigan, to prevent the destruction of the through routes of communication across Keweenaw Point, and rules and regulations were prescribed for maintaining them. Notwithstanding these regulations the stamp-mills on Portage Lake continued to dump their tailings outside of these lines, and the United States attorney for western Michigan was instructed by the Department of Justice to apply for an injunction restraining the mill owners from dumping débris into Portage Lake between the harbor-lines established by the Secretary of War.

(See Appendix G G 4.)

5. *Marquette Harbor, Michigan.*—The present project for the improvement of this harbor was adopted in 1866, and consisted in the construction of a crib breakwater 2,000 feet long and 25 to 40 feet wide, built to a height of 6 feet above the water-surface, the estimated cost being $385,129.58. Previous to the commencement of the work these widths were changed to 20, 25, and 30 feet. The structure was completed in 1875, the total length being 2,010 feet and the total cost $290,646.55.

In its original condition this harbor afforded no protection to vessels during the prevalence of easterly and northerly gales.

Since the completion of the original project commerce has increased so much that additional protection is needed and should be afforded, and for this purpose it is recommended that the present breakwater be extended 1,200 feet, which will increase the available anchorage over 100 per cent. and afford ample protection for the present commerce.

Some damage having been done to the breakwater by the October gales of 1887, repairs were made at a cost of $738.86.

It is believed that the encroachment upon the available protected area, heretofore complained of, will be adjusted satisfactorily.

July 1, 1887, amount available	$10,323.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,322.96
July 1, 1888, balance available	9,000.86
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	34,000.86

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Amount (estimated) required for completion of proposed project	$175,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 5.)

6. *Harbor of Refuge, Grand Marais, Michigan.*—The present project for the improvement of this harbor was adopted in 1881, the object being to provide a harbor of refuge for vessels navigating Lake Superior, and consists in the formation of an artificial entrance to the natural harbor of Grand Marais, having an available capacity of 160 acres, capable of being increased to 240 acres hereafter in case the increased needs of commerce demand it.

This artificial entrance is to be formed of two parallel crib-piers 500 feet apart, with a dredged channel between 300 feet wide and 18 to 20 feet deep, cut through the sand-spit north of the harbor, connecting the deep water of the lake with that of the harbor.

The natural channel was variable and crooked, with but 6 feet of water.

The contract made October 25, 1886, for building 450 feet of crib-pier was abandoned by the contractor early in the present fiscal year, and another contract was then entered into with the next lowest bidder for 400 feet of pier extension, but owing to the season being far advanced and the difficulty of obtaining stone, work was suspended and the time of completion extended to July 31, 1888.

Under this contract during the month of June, 1888, the west pier was extended 200 feet by four cribs, each 24 feet in width. To complete the existing contract four more cribs are to be sunk during the month of July, 1888.

July 1, 1887, amount available		$28,251.91
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,152.59	
July 1, 1888, outstanding liabilities	859.77	
July 1, 1888, amount covered by existing contracts	16,400.00	
		26,412.36
July 1, 1888, balance available		1,839.55
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		51,839.55

Amount (estimated) required for completion of existing project	268,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 6.)

7. *Manistique Harbor, Michigan.*—The present project for the improvement of this harbor was adopted in 1880, and consisted in dredging between the piers built by the Chicago Lumbering Company, increasing the depth of the channel to 12 feet for a width of 150 feet.

The natural channel of entrance to the mouth of the Manistique River was 7 feet deep. By private enterprise a slab-pier 3,000 feet long had been built at the mouth of the river and a channel dredged to 10 feet before any appropriation had been made by the Government.

By the acts of 1880 and 1881 the sum of $6,000 was appropriated for this harbor in order to dredge a channel 150 feet wide and 12 feet deep between the piers built by a local lumbering company. Dredging was done to the amount of 11,780 cubic yards, and the work was then sus-

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pended in consequence of the refusal of the company controlling the harbor to rectify their pier lines when rebuilding the same.

No work has been done during the year.

No appropriation is asked for this harbor.

July 1, 1887, amount available	$3,501.79
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	400.00
July 1, 1888, balance available	3,101.79

(See Appendix G G 7.)

8. *Cedar River Harbor, Michigan.*—The present project for the improvement of this harbor was adopted in 1882, with a modification in the direction of the piers in 1884, the object being to afford a channel of entrance of navigable width and 14 feet in depth.

Previous to the improvement the mouth of the river was 175 feet wide and 8 to 10 feet deep with a 3-foot bar in front of the mouth. Improvements have been made by private parties prior to the commencement of Government work.

The amount expended to June 30, 1888, is $27,664.98, and has resulted in the construction of two pile-piers 754 and 350 feet long, respectively, in continuation of the slab-docks built by private parties, and a channel that at last accounts, October, 1885, was 50 feet wide and 13 feet deep, and 100 feet wide for a depth of 11 feet.

For the next fiscal year no appropriation is asked for the commerce of Cedar River being entirely local.

July 1, 1887, amount available	$2,670.02
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	335.00
July 1, 1888, balance available	2,335.02
Amount (estimated) required for completion of existing project	108,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 8.)

9. *Menomonee Harbor, Michigan and Wisconsin.*—The present project for the improvement of this harbor was adopted in 1871 and modified in 1874, the object being to afford a channel of entrance of navigable width and not less than 14 feet depth.

Previous to the improvement of this harbor the depth of water at the mouth of the Menomonee River was about 4 feet, and the river was navigable for boats of that draught for some 2 miles above its mouth.

The amount expended to June 30, 1888, is $200,616.80, and has resulted in the construction of two piers, with a dredged channel between, 14 feet deep and 270 feet wide, this channel extending across a bar about 350 feet beyond the south pier. The north pier consists of three parts, 585 feet of slab-pier, 609 feet of pile-pier, and 660 feet of cribs, or a total of 1,854 feet. The south pier consists of 1,900 feet of pile-pier and 810 feet of cribs, making a total of 2,710 feet.

July 1, 1887, amount available	$3,100.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	730.21
July 1, 1888, balance available	2,370.30
Amount appropriated by act of August 11, 1888	9,000.00
Amount available for fiscal year ending June 30, 1889	11,370.30

(See Appendix G G 9.)

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10. *Oconto Harbor, Wisconsin.*—In its natural condition the channel at the entrance to Oconto River was obstructed by a bar with less than 2 feet of water over it. Previous to 1881, when the first appropriation was made for its improvement, the citizens had, by the construction of a small amount of slab-pier and by dredging, increased the depth to 3½ feet.

The project of improvement proposes to secure an 8 foot channel from deep water in Green Bay to the city of Oconto by dredging and the construction of piers, at an estimated cost of $150,000.

During the fiscal year ending June 30, 1888, 1,200 feet of reinforcement piling on the channel side of the south pier was built by hired labor.

The total amount expended to June 30, 1888, is $47,778.86, resulting in the building of two piers, the north pier 1,603 feet and the south one 2,151 feet in length, the latter being the full length contemplated by the approved project, and in the removal of 207,641 cubic yards of material by dredging.

The navigation interests at Oconto are at present dependent upon the business of three lumber companies located there, and the benefits to be desired are essentially local.

July 1, 1887, amount available	$1,104.14
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,904.50
July 1, 1888, balance available	199.64
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	20,199.64
Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 10.)

11. *Pensaukee Harbor, Wisconsin.*—The first appropriation for this harbor was made in 1882. At that time the facilities of the natural channel of the Pensaukee River had been increased by private enterprise by the construction of 1,600 linear feet of continuous slab-pier and by dredging from a depth of 2 feet to a depth varying from 7 to 9 feet, with a width of 30 feet.

The project of improvement of this harbor, adopted in 1882, consists in the construction of a single slab-pier 2,500 feet in length in continuation of the pier built by private enterprise, and the dredging of a channel 10 feet deep and 100 feet wide on the south side of the pier.

There was no work done at this harbor during the fiscal year.

The total amount expended to June 30, 1888, is $10,939.08, resulting in the construction of 1,300 feet of the proposed extension of the pier and the dredging of 5,698 cubic yards of material, making a channel 25 feet wide and 10 feet deep. The entire length of the pier is 2,900 feet, the inshore 1,600 feet having been built by private enterprise.

There being at present no commercial or navigation interests to be benefited by improving the harbor, and the harbor itself not being needed as a harbor of refuge, further operations have been suspended.

July 1, 1887, amount available	$4,446.92
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	387.00
July 1, 1888, balance available	4,059.92

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Amounted (estimated) required for completion of existing project.....	$35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 11.)

12. *Green Bay Harbor, Wisconsin.*—Before the improvement of this harbor was begun the channel between the mouth of Fox River and the deep water in Green Bay was circuitous and narrow, with but 6 feet of water at its shoalest point.

The project was adopted in 1866 and modified in 1872 and 1881, its object being to secure a channel 200 feet wide, 14 feet deep, and 2 miles long, in place of the natural channel, with a revetted cut across Grassy Island.

During the fiscal year ending June 30, 1888, the superstructure of the west revetment at Grassy Island has been rebuilt for the entire length of 620 feet.

The total expenditures since the beginning of the improvement amount to $277,372.97, resulting in a dredged channel 10,600 feet long, 200 feet wide, and 14 feet deep, except where occasional shoals reduce the depth to 13 feet, and the construction of 1,325 linear feet of pile and timber revetment on the sides of the cut through Grassy Island.

The appropriation asked for will be applied to dredging the channel to the dimensions called for by the present project.

July 1, 1887, amount available	$5,437.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887.....	5,229.61
July 1, 1888, balance available.....	208.03
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,208.03

Amount (estimated) required for completion of existing project.....	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 12.)

13.—*Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.*—Before the construction of this harbor was undertaken the location afforded no shelter at all from storms ranging from northeast to southwest.

The project of constructing a harbor of refuge at this point was adopted in 1873 and modified in 1879 and 1880. The modified project as carried out consists of two piers, each 1,344 feet long, 850 feet apart at the shore-line, protecting the lake entrance of the canal, and converging so as to make the harbor entrance 335 feet wide, inclosing an area of about 10 acres.

No work was done during the fiscal year ending June 30, 1888.

The total expenditure at this harbor since the beginning of the improvement has been $161,354.58, resulting in the entire completion of the piers as projected, and in the dredging of 132,344 cubic yards of material, giving a channel 16 feet deep at the entrance and 14 feet or more thence to the canal, making a depth of 14 feet over the greater part of the sheltered area.

No money is asked for during the fiscal year ending June 30, 1890, as it is thought the unexpended balance will be sufficient for maintenance and repairs.

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July 1, 1887, amount available	$4,027.71
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	387.29
July 1, 1888, balance available	3,640.42

(See Appendix G G 13.)

14. *Ahnapee Harbor, Wisconsin.*—Previous to the improvement of this harbor the depth of water at the mouth of the Wolf River was only about 2 feet.

The project of improvement, adopted in 1875 and modified in 1884, provided for the formation of a small artificial harbor, connected with the lake by a channel 100 feet wide and 12 feet deep, formed by the construction of two piers extending to the 18-foot contour, with a 200-foot entrance between the pier-heads.

Owing to the proviso in the appropriation act of August 5, 1886, that wharfage over the Government piers must be made free, no work has been done during the fiscal year ending June 30, 1888.

The total amount expended to June 30, 1888, is $139,660.88, and has resulted in the construction of two piers, the north one 902 feet long, and the south one 1,125 feet, the outer 100 feet of the north pier and 150 feet of the south pier being without superstructure, and in the removal of 22,233 cubic yards of rock and 82,343 cubic yards of sand.

July 1, 1887, amount available	$15,433.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	158.80
July 1, 1888, balance available	15,274.62
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	20,274.62
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 14.)

15. *Kewaunee Harbor, Wisconsin.*—The natural entrance to this harbor was *via* the Kewaunee River. The river mouth was not more than 20 feet wide, with a depth of about 2 feet at its shoalest point, and obstructed by submerged bowlders.

The project of improvement was adopted in 1881. Its design was to cut a channel through a neck of land between the river and the lake at a point about 2,000 feet south of the river mouth, and to continue this channel to deep water in the lake by the construction of two parallel piers 200 feet apart, extending from each side of the cut lakeward to the 18-foot curve.

During the fiscal year ending June 30, 1888, north pier was extended 200 feet by contract, and by hired labor and open purchase 15¾ cords of stone were placed at the junction of the north pier with the shore to prevent a breach.

The total amount expended to June 30, 1888, has been $44,776.23, in addition to which the local harbor commissioners have expended $8,042.72. These expenditures have resulted in the construction of 1,000 feet of north pier and 775 feet of south pier, and in the dredging of a channel 100 feet wide and 10 to 12 feet deep, 9,035 cubic yards of material having been removed by the Government dredges.

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July 1, 1887, amount available	$7,658.84
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,469.47
July 1, 1888, balance available	189.37
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,189.37
Amount (estimated) required for completion of existing project	137,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 15.)

16. *Two Rivers Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel was obstructed by a bar covered by but 2 or 3 feet of water.

The project of improvement adopted in 1870 provided for the formation of a channel of navigable width and not less than 12 feet deep. This was to be accomplished by the construction of two piers extending from the river mouth lakeward to the 18-foot contour in Lake Michigan and by dredging.

During the year ending June 30, 1888, no work has been done. The total expenditures to June 30, 1888, are $197,864.67, resulting in the construction of two parallel piers, as follows: A north pier 1,810 feet long, the inner 1,060 linear feet of which consists of pile-pier and the outer 750 feet of crib-pier; a south pier 1,710 feet long, 960 linear feet of which is pile-pier and the outer 750 feet crib-pier; the crib sections of the two piers begin at points opposite, and are 230 feet apart. The pile sections are 270 feet apart; 240,600 cubic yards of material have been removed by dredging.

At the close of dredging operations in 1885 there was a channel of 12 feet, 180 feet wide, but in May, 1887, there was only a narrow channel about 10 feet deep.

July 1, 1887, amount available	$135.33
July 1, 1888, balance available	135.33
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,635.33
Amount (estimated) required for completion of existing project	65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 16.)

17. *Manitowoc Harbor, Wisconsin.*—Previous to the improvement of this harbor but 3 feet of water existed at the shoalest point over the bar at the mouth of the Manitowoc River.

The original project adopted in 1852 provided for the construction of two parallel piers 220 feet apart and extending from the river mouth to the 12-foot contour in Lake Michigan. This was modified in 1881 to extending the piers to the 18½-foot contour and obtaining a channel not less than 14 feet deep.

During the fiscal year ending June 30, 1888, under contract, the south pier was extended 50 feet and 250 feet of the superstructure of the same pier built.

This completes the present project, but about 1,600 feet of superstructure is from seventeen to twenty-one years old, is in bad condition, and should be rebuilt at once.

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The total amount expended to June 30, 1888, is $291,383.15, and has resulted in the construction of two piers, 1,970 and 1,900 feet long, 228 feet apart at the shore-line, and 250 feet at the outer ends, and in the dredging of 156,877 cubic yards of material.

July 1, 1887, amount available	$8,905.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,416.15
July 1, 1888, balance available	488.85
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	8,488.85
Amount (estimated) required for completion of existing project	8,362.54
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 17.)

18. *Sheboygan Harbor, Wisconsin.*—Previous to the improvement of this harbor the natural channel had a depth not exceeding 4 feet on the bar at the entrance to the river.

The project for the improvement of this harbor was adopted in 1852 and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost and a channel was formed 100 feet wide with a depth of 15 to 16 feet between the piers. The existing project was adopted in 1881, its object being to deepen the channel still further by extending the piers to the 20-foot contour in the lake and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore-line. There is now a navigable channel with a depth of about 13 feet.

During the fiscal year ending June 30, 1888, the north pier was extended 200 feet, the work being done by contract. By hired labor 4,410 cubic yards of material were removed from the channel.

The total expenditures to June 30, 1888, have amounted to $287,759.36 and have resulted in the construction of two piers 2,044 and 2,260 feet long, respectively, built of cribs (except less than 300 feet at the shore end), of widths of from 14 to 20 feet, and in dredging 187,043 cubic yards of material from the channel.

The only means of securing a permanent channel is by rapid extension of the piers to deep water; hence a liberal appropriation is urged as a matter of economy and of necessity to the commerce of this important harbor.

July 1, 1887, amount available	$13,521.79
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,892.44
July 1, 1888, balance available	629.35
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,629.35
Amount (estimated) required for completion of existing project	82,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix G G 18.)

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19. *Port Washington Harbor, Wisconsin.*—The present project for the improvement of this harbor, adopted in 1869 and modified in 1870 and 1876, was for the formation by dredging of two interior basins having a combined area of about 5¾ acres, with a depth of 12 feet, and a channel of the same depth connecting them with the lake, the channel entrance to the basins to be north of the mouth of the Sauk River, inclosed between two piers so constructed that the flow of the river should be separated from the channel, and that the débris brought down by freshets, instead of shoaling the channel, should re-enforce the south pier.

The natural channel at the mouth of the Sauk River was narrow, and at the shoalest point had a depth of but 1 foot.

During the fiscal year ending June 30, 1888, $681.56 were expended in building 50 feet of superstructure on the north pier.

The amount expended to June 30, 1888, is $168,468.53, exclusive of outstanding liabilities, and has resulted in the construction of a north and south pier 920 and 1,226 feet long, respectively, with 400 feet revetment along the north bank of the river, extending to the inner end of the south pier; in the formation of two interior dredged basins of 2¾ and 3 acres, respectively, with an average depth of about 9 feet in the north and 8 feet in the west basin, and in making a navigable channel between the piers of 11 feet.

July 1, 1887, amount available	$2,216.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,177.16
July 1, 1888, balance available	1,039.37
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	6,039.37
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	7,000.00

(See Appendix G G 19.)

CONSTRUCTION OF HARBOR OF REFUGE, MILWAUKEE BAY—IMPROVEMENT OF THE HARBORS OF MILWAUKEE, RACINE, AND KENOSHA, WISCONSIN, AND WAUKEGAN, CHICAGO, AND CALUMET, ILLINOIS—IMPROVEMENT OF ILLINOIS, CALUMET, FOX, AND WISCONSIN RIVERS.

Officer in charge, Capt. W. L. Marshall, Corps of Engineers, with Lieut. G. D. Fitch, Corps of Engineers, under his immediate orders.

1. *Harbor of Refuge, Milwaukee Bay, Wisconsin.*—The project for the work was approved in 1881, and contemplated the formation of an artificial harbor by inclosing a portion of Lake Michigan within an outer breakwater of crib-work upon a stone foundation. This harbor will furnish 417 acres of safe mooring ground beyond the 18-foot curve and about twice this area beyond the 12-foot curve.

Work began in 1881, and up to June 30, 1888, there had been expended $330,562.34, resulting in the completion of 3,300 linear feet of the substructure of the breakwater, over which 3,100 linear feet of superstructure has been built.

During the fiscal year ending June 30, 1888, the east arm of the breakwater was extended 100 linear feet, and superstructure built over 400 linear feet of substructure.

The breakwater when completed will be 7,250 feet in length; there

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remains, then, to be constructed 3,950 linear feet of substructure and 4,150 linear feet of superstructure to complete the work.

The balance of appropriation now available is barely sufficient to maintain the necessary lights upon the unfinished pier during the present season.

The funds asked for the fiscal year ending June 30, 1890, are to be applied to the extension southward of the east arm of the breakwater.

The harbor is now used to a limited extent as a shelter from northeast storms. Its value will rapidly increase as the east arm is extended.

July 1, 1887, amount available	$39,754.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887, and including $4,737.91 expended on Milwaukee Harbor	36,116.35
July 1, 1888, balance available	3,638.23
Amount appropriated by act of August 11, 1888	70,000.00
Amount available for fiscal year ending June 30, 1889	73,638.23
Amount (estimated) required for completion of existing project	418,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 1.)

2. *Milwaukee Harbor, Wisconsin.*—The present project was adopted in 1852, and was directed to securing 12 feet of water at the entrance to the river and to protecting this channel by parallel piers. Since that date a channel, 18 feet in depth and of sufficient width, has been formed by extending the piers and dredging. The project has been completed, and consequently the only expenditures now demanded are for the maintenance of the piers by timely repairs and the depth of the channel by dredging.

The original depth of water at the mouth of the river was not more than 3½ feet.

The United States has expended on this harbor up to June 30, 1888, $289,586.08, in addition to $321,355.66 by the city of Milwaukee. Of the above expenditure $4,737.91 were expended by allotment from the appropriation of August 5, 1886, for "Harbor of Refuge, Milwaukee Bay and Harbor."

During the fiscal year ending June 30, 1888, 336 linear feet of superstructure over the outer section of the north pier have been cut down and rebuilt.

There are no funds now available for this work.

The superstructure over the outer section of the south pier is in urgent need of rebuilding, and repairs are necessary at the west ends of both piers, where they have been damaged by collisions.

The pile protection to the stone superstructure of the inner section of the north pier is also in need of repair, and dredging is needed to maintain the channel, which has deteriorated to 17 feet, through a narrow channel.

July 1, 1887, amount available	$7,901.95
Amount allotted from act of August 5, 1886, for Milwaukee Bay and Harbor	4,737.91
	12,639.86
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,639.86
Amount appropriated by act of August 11, 1888	10,000.00

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Amount (estimated) required for completion of existing project	$12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 2.)

3. *Racine Harbor, Wisconsin.*—The entrance to this harbor originally varied in depth from absolute closure after storms to about 6 feet.

The present project was adopted in 1843, and contemplated originally a channel 12 feet in depth. The piers have since been further extended and the channel deepened to 16 feet by dredging.

There has been expended upon this harbor up to June 30, 1888, $231,707.02.

There being no sufficient funds available for this harbor during the past fiscal year no work has been done.

The harbor is in urgent need of dredging. The channel has deteriorated from 16 feet in depth until it is now barely practicable for vessels drawing 12½ feet of water; nearly 40,000 cubic yards of dredging is required to restore the channel.

The south pier should be extended also, and the present wide mouth of the channel somewhat contracted.

July 1, 1887, amount available	$774.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	174.56
July 1, 1888, balance available	599.48
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,599.48

Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 3.)

4. *Kenosha Harbor, Wisconsin.*—The present plan of improvement by parallel piers and dredging was first directed to securing a channel 12 feet in depth. The depth of water in the channel at the present stage of water in Lake Michigan is 11 feet; at ordinary low water it is only 12 feet. The original depth was 4 feet or less; sometimes it was entirely closed.

This harbor was dredged in 1875–'76 to 15 feet in depth, but the appropriations have been insufficient to maintain the work, and it had deteriorated to 10½ feet in depth at the beginning of the present fiscal year, or nearly 5 feet in available depth. It is now 12½ feet in depth.

There has been expended upon this harbor up to June 30, 1888, $221,153.64.

During the fiscal year ending June 30, 1888, 49 white-oak piles were driven along the channel-face of the inner section of the south pier by contract, and 7,272 cubic yards of sand excavated from the channel, restoring the depth over a channel width of 40 feet to 14 feet in depth, which has again deteriorated, as shown above, to 12½ feet in depth.

Twenty-eight thousand cubic yards of dredging is urgently required, and the sections of superstructure built in 1872–'74, are now rotten and require renewal.

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July 1, 1887, amount available	$5,547.17
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,747.24
July 1, 1888, balance available	799.93
Amount appropriated by act of August 11, 1888	7,500.00
Amount available for fiscal year ending June 30, 1889	8,299.93

Amount (estimated) required for completion of existing project	33,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 4.)

5. *Waukegan Harbor, Illinois.*—The present project was adopted in 1880, and, as since modified, consists in excavating a small basin in the low ground between the lake and the bluffs to form the harbor, and in dredging an entrance between parallel piers from the lake to the basin.

The harbor here is to be created upon a shallow exposed coast, and will not begin to be available for commercial purposes until the piers are sufficiently extended into the lake to allow the entrance to be dredged with hope of permanency and the basin excavated.

There has been expended upon this harbor up to the close of the fiscal year, June 30, 1888, $89,725.20.

During the year ending June 30, 1888, the south pier was extended 71 feet in length; stone was also placed in and around the piers where it had become deficient from the washing out of the sand at base by storms, and 257 piles have been purchased for the continuance of the work, when funds are made available.

July 1, 1887, amount available	$9,318.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,043.31
July 1, 1888, balance available	274.80
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,274.80

Amount (estimated) required for completion of exising project	46,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 5.)

6. *Fox and Wisconsin Rivers, Wisconsin.*—The works for the improvement of the Fox and Wisconsin rivers were purchased by the United States from the Green Bay and Mississippi Canal Company in 1872. These works were all, except one stone lock, temporary structures, all of them in bad condition. There was no low-water navigation on the Upper Fox, and on the Lower Fox navigation was uncertain.

For the Fox River.—The adopted project contemplated the replacing of the temporary structures with permanent works, the construction of five additional stone locks on the Upper Fox, and widening and deepening the channels throughout the river and canals to 6 feet depth and 100 feet width.

For the Wisconsin River.—The method adopted has been to contract the channel-way by wing-dams of brush and stone, to give increased depth by concentrating the water and by scour due to the increased currents. The estimate, including the Wisconsin River, made in 1874

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and 1876, was $3,745,663, since which time there has been appropriated $1,780,000, leaving for completion of the adopted project $1,965,663.

The general subject of the improvement of the Fox and Wisconsin rivers was referred to the Board of Engineers, who, after systematic observations of the effect of the dams on the improved section of the Wisconsin River, submitted a report contained in House Ex. Doc. No. 65, Forty-ninth Congress, second session, recommending that no further work be done on wing-dams in the Wisconsin River with a view to improve its navigation.

The original project, therefore, as far as it relates to the Wisconsin River, has been definitely condemned, and the work confined to the Fox River, under the modified project of a Board of Engineers submitted September 17, 1884, published in the Annual Report of the Chief of Engineers for 1885, approved by the Secretary of War December 10, 1884, as further modified by authority of the Chief of Engineers May 14, 1886.

The modified project applies only to the Fox River and its needs, and contemplates the renovation of eleven old locks and the deepening and widening the channel of the Fox River from Montello to Green Bay to 6 feet depth and 100 feet width, the estimate for which is $602,000. Of this amount $56,250 were appropriated August 5, 1886.

The amount expended on the improvement of the Fox and Wisconsin Rivers from 1867 to date, including outstanding liabilities and $145,000 paid to the Green Bay and Mississippi Canal Company for works of improvement under act of June 10, 1872, is $2,693,003.62.

The result of this expenditure has been:

On the Fox River.—The construction of 14 new locks of stone; 13 dams, 4 of which are temporary; 12 cut-offs; 10 miles of canals dredged and deepened. Over 2,000,000 cubic yards of material have been dredged from the Upper Fox, and all temporary structures repaired and maintained in working order. The navigation has thus been continuous throughout the season from Portage to Green Bay, there being at an ordinary stage of water 2½ feet navigation on the Upper Fox and 5½ feet on the Lower Fox, except at the entrance of Lake Winnebago, where there is only 4½ feet. During the months July to November, 1887, inclusive, navigation was partially suspended from Lake Winnebago to Appleton, due to the mills drawing more water than the discharge of the Fox River, thus lowering the levels of the Lake Winnebago and Little Butte des Morts pools.

Under the modified project, there remains to be done 2,800,000 cubic yards of dredging and rock excavation, mainly upon the Upper Fox, and one dam at Appleton, with sluice-ways; the old works to be maintained under the continuous appropriation.

On the Wisconsin River.—To date 108,512 linear feet of wing-dams have been constructed over a distance of 50 miles, of which a section 9.2 miles in length below Portage has been completed. The result has been an increased depth of navigation wherever the works have been applied. There is not now, nor has there been, any regular navigation on the Wisconsin River, due to the prevalence and shifting nature of the sand-bars and the consequent lack of any defined channel for considerable distances.

The question of the practicability of improving the open-river navigation of the Wisconsin by wing-dams in the bed of the river, to the extent required for an effective through route of navigation, has been decided in the negative, and the work on that stream definitely abandoned.

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During the fiscal year ending June 30, 1888, the following work has been done:

On the Wisconsin River.—Nothing.

On the Upper Fox.—The work was confined to the maintenance of the channel by dredging, and to timely repairs to locks, dams, and embankments.

On the Lower Fox.—Dredging was continued in the Menasha Channel, to connect the deep rock cut with deep water in the lake.

The various works on the Lower Fox were maintained in serviceable condition. The old locks, Kaukauna 5th and Appleton 3d, were practically rebuilt; a deep dredge cut was made from Menasha Lock to deep water in Little Lake, Butte des Morts; new lock gates built where required, and general repairs made to locks, dams, and canal banks.

July 1, 1887, amount available	$44,300.28
Fuel sold to officers, deposited to credit of appropriation	175.00
	44,475.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24,535.67
July 1, 1888, balance available	19,939.61
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	119,939.61
Amount (estimated) required for completion of existing project, Fox River	446,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 6.)

7. *Operating and care of locks and dams on the Fox and Wisconsin rivers, Wisconsin.*—Under the continuous appropriation for operating and care of canals and other works of navigation, it is proposed to maintain existing navigation by timely repairs to old locks until they are replaced by new, and to continue the repairs of works that have already been completed and used, injured by the extraordinary flood of 1881.

July 1, 1888, amount expended during the fiscal year	$52,204.77
Amount (estimated) for expenditure in fiscal year ending June 30, 1889	48,900.00

(See Appendix H H 7.)

8. *Chicago Harbor, Illinois.*—In charge of Maj. Thos. H. Handbury, Corps of Engineers, to March 31, 1888. The present project was adopted in 1870 and modified in 1878.

The project consists in:

The formation of an outer harbor or basin, by inclosing a portion of Lake Michigan just south of and adjoining the entrance to Chicago River, for the purpose of increasing the harbor facilities of the port of Chicago.

The construction of an *exterior breakwater* of crib-work filled with stone, outside of the outer harbor in deep water to shelter the approach to the river and outer harbor entrances, and to form a harbor of refuge at the southern end of Lake Michigan.

There has been expended upon this project since 1870, $1,409,819.02 and has resulted:

In the completion of the outer harbor, except 267,000 cubic yards of dredging, to attain 16 feet in depth throughout the basin required.

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In the completion of 4,236 linear feet of the exterior breakwater.

During the past fiscal year the work consisted in:

The construction of experimental permanent superstructure of concrete over 95 feet about midway on the easterly breakwater of the outer harbor.

The completion, by hired labor, of 400 linear feet of superstructure over the outer extremity of the exterior breakwater for the harbor of refuge.

To complete the work of improvement upon the harbor of refuge and outer basin requires an estimated sum of $240,000.

The whole of the superstructure over the easterly breakwater of the outer basin and over part of the north pier of the entrance to Chicago River, is now in an unsafe and rotten condition and requires renewal. One hundred and twenty thousand dollars is required to build these superstructures.

The dredging in the outer basin is not urgent and can be postponed until the basin is demanded for harbor and dock purposes, when the material will be valuable for filling. It should not be further dredged and wasted.

At the entrance to the Chicago River the channel has now deteriorated to a depth in places of only 11.8 feet in depth. It is unnecessary to say that an appropriation for this work is very urgently needed. An estimate of $12,000 is submitted for this purpose to restore the depth to 16 feet. This, the greatest port on the lakes, should have its harbor deepened to 18 feet. It is now in places about 12 feet, but a 15-foot channel is found.

Estimated for completion of outer basin and harbor of refuge	$240,000.00
For superstructure over east and north piers	120,000.00
For dredging Chicago River entrance	12,000.00
Total	372,000.00
July 1, 1887, amount available	20,974.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	18,212.81
July 1, 1888, balance available	2,761.30
Amount appropriated by act of August 11, 1888	200,000.00
Amount available for fiscal year ending June 30, 1889	202,761.30
Amount (estimated) required for completion of existing project	172,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	172,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 8.)

9. *Calumet Harbor, Illinois.*—(In charge of Maj. Thos. H. Handbury, bury, Corps of Engineers, to March 31, 1888.) This improvement is to furnish a safe and practicable entrance to Calumet River and the port of South Chicago, by parallel piers, 300 feet apart, extending from shore to deep water in the lake, and by dredging between them to 16 feet in depth at low water.

The work commenced in 1870, and at the close of the fiscal year 1888 there had been expended $391,222.30. As the result of which 3,600 linear feet of the north pier and 1,870 feet of the south pier had been completed, and 384,376 cubic yards of material dredged, giving a channel 16 feet in depth instead of 7 feet, as found here before improvement.

During the past year no work has been done for lack of appropriations.

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Additional dredging to secure 16 feet in depth is needed in the channel, which has deteriorated. The south pier should be extended 150 linear feet to complete the original project. The north and south piers need additional stone, particularly the outer end of the north pier, which is in very insecure condition, and the superstructure on portions of the north and south piers are rotten for a length of 1,600 linear feet.

The funds available and asked for the fiscal year ending June 30, 1890, are to be applied to the above-described works, viz:

For dredging	$21,000.00
Rebuilding superstructure	22,500.90
Completing original project	20,400.00
Total	63,900.00

All of which can be profitably expended in one year.

July 1, 1887, amount available	$871.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	93.88
July 1, 1888, balance available	777.70
Amount appropriated by act of August 11, 1888	20,400.00
Amount available for fiscal year ending June 30, 1889	21,177.70
Amount (estimated) required for maintenance	43,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	43,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 9.)

10. *Illinois River, Illinois.*—(In charge of Maj. Thos. H. Handbury, Corps of Engineers, to March 31, 1888.) The present project contemplates the extension of the work heretofore done by the State of Illinois, from the mouth of Copperas Creek to the Mississippi River, a distance of 135 miles, which project includes the building of two locks, 350 feet long, 75 feet wide, and with 7 feet at low water over the miter-sills, and dredging the channels where necessary to 7 feet deep at low water.

The sites selected for the two locks are, one at Kampsville, 30 miles above the mouth of the Illinois, the other at La Grange, 45 miles above Kampsville.

The ultimate object of the improvement is the construction of a ship-canal from the southern end of Lake Michigan to the Mississippi River of sufficient capacity to accommodate large-sized Mississippi steamboats, and for military and naval purposes.

The State of Illinois, aided by the United States, has executed part of this project by the construction of two locks of the dimensions above stated, one at Henry and one at Copperas Creek, completing that part of the improvement between La Salle, Ill., and the mouth of Copperas Creek.

The La Grange Lock is now completed, with the exception of guide-piers, and filling behind the lock. The foundation of the Kampsville lock is completed and part of the stone cut and delivered. Both dams are still to be constructed, the Kampsville lock completed, and dredging done amounting to more than 2,000,000 cubic yards. In executing this work the United States has expended up to the close of the fiscal year ending June 30, 1888, $712,141.45, exclusive of $62,359.80 expended on the foundation of the Copperas Creek Lock, which was afterwards completed by the State of Illinois. An additional amount of $747,747

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was expended by the State of Illinois on Henry and Copperas Creek Locks.

To complete the present project requires the sum (estimated) of $587,500.

During the fiscal year ending June 30, 1888, the following work was done:

a. La Grange Lock.—The sediment deposited in this lock was removed; the foundation floor planked over with 2-inch pine plank; lower miter-still set and secured; gates, valves, maneuvering machinery and snubbing posts placed, and the lower tail-bay mattressed and ballasted, and part of the filling behind the lock-wall placed.

b. Kampsville Lock.—Two thousand eight hundred and eighty-one and eight-tenths cubic yards of cut stone was received and piled.

c. Dredging in channel.—Twenty-six thousand five hundred and sixty-one cubic yards of material was dredged and removed from the channel where work was most needed.

The boats, dredges, etc., were repaired and maintained, and 121 snags removed from the channel.

The amount asked for the fiscal year ending June 30, 1890, can be expended advantageously upon the locks and dams at La Grange and Kampsville, and in dredging operations.

Plans and estimates of cost of continuing this improvement to Joliet, Ill., have been submitted to Congress, but no surveys or estimates have been made for continuing the improvement from Joliet to Lake Michigan. Practicable routes are known to exist. It is suggested that $10,000 be made available for making proper surveys and preparing plans and estimates for this continuation.

The report of the Board of Engineer Officers constituted to examine, in all their relations to commerce, the Illinois and Michigan Canal, and the proposed Hennepin Canal, with their value and usefulness to navigation, and to report upon the acquisition and improvement of the Illinois and Michigan Canal and the construction of the Hennepin Canal, was transmitted to Congress January 10, 1887, and printed as House Ex. Doc. No. 79, Forty-ninth Congress, second session, also published in the Annual Report of the Chief of Engineers, U. S. A., for 1887, Appendix II, page 2125, *et seq.*

July 1, 1887, amount available	$41,735.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	31,508.03
July 1, 1888, balance available	10,227.35
Amount appropriated by act of August 11, 1888	200,000.00
Amount available for fiscal year ending June 30, 1889	210,227.35
Amount (estimated) required for completion of existing project	387,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	387,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 10.)

11. *Calumet River, Illinois and Indiana.*—In charge of Maj. Thos. H. Handbury, Corps of Engineers, to March 31, 1888. The object of this improvement, so far as at present projected, is to secure a channel 200 feet wide and 16 feet deep from Calumet Harbor, Illinois, to one-half mile east of Hammond, Ind., with the view to increasing the facilities for handling the growing commerce of this region, and also to aid in providing means for the better accommodation of much of the commerce of Chicago, which is now very much crowded in that city.

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The river and harbor act of July 5, 1884, appropriated $50,000 for the improvement of that section of the river from the harbor to the outlet from Lake Calumet, with the proviso—

That no part of said sum shall be expended until the right of way shall have been conveyed to the United States free from expense, and the United States shall be fully released from all liability for damage to adjacent property owners, to the satisfaction of the Secretary of War.

Parties directly interested have for some time been actively engaged in securing to the United States the right of way and releases required. The matter is now so far advanced as to be placed in the hands of the United States district attorney for the northern district of Illinois for examination of titles and preparation of the necessary legal papers.

Work will be commenced on this section of the river as soon as the requirements of the proviso shall have been complied with.

The river and harbor act of August 5, 1886, appropriated an additional sum of $30,000 for the improvement of this river, $11,750 of which were to be expended in improving the river "between the Forks and one-half mile east of Hammond, Ind.," one-half of which to be expended in Illinois and one-half in Indiana.

The work during the year ending June 30, 1888, was confined to that indicated in the above provision of the act of August 5, 1886, *i. e.*, to dredging between the "Forks and one-half mile east of Hammond, Ind.," by contract with the lowest responsible bidder.

Thirty-seven thousand seven hundred and forty-three cubic yards of material were removed in Indiana at Hammond, and 39,061 cubic yards in Illinois at Burnham.

The amount expended by the United States upon this work up to June 30, 1888, is $11,095.52.

July 1, 1887, amount available	$79,227.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10,323.02
July 1, 1888, balance available	68,904.48
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	118,904.48
Amount (estimated) required for completion of existing project	295,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix H H 11.)

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

Officers in charge, Capt. D. W. Lockwood, Corps of Engineers, to March 28, 1888, since which date Maj. S. M. Mansfield, Corps of Engineers, having under his immediate orders since May 15, 1888, Lieut. J. E. Kuhn, Corps of Engineers.

1. *Charlevoix Harbor and entrance to Pine Lake, Michigan.*—The average width of the original channel of entrance was 75 feet; the depth varied from 2 to 6 feet. The present project for its improvement, adopted in 1868 and revised in 1875 and 1876, is to dredge a channel 100 to 150 feet wide, connecting Round Lake with Lake Michigan, to a depth of 12 feet, and to protect both sides with close piling. This was modified in 1876 by substituting crib-work for pile-piers beyond the

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shore-line in Lake Michigan. An additional modification in 1882 provided for a revetted channel between Round and Pine lakes.

The present channel of entrance is from 160 to 105 feet wide, and the channel between Round and Pine lakes is 83 feet wide. The available depth for navigation is about 10 feet. The amount expended to June 30, 1887, was $70,710.82, and has resulted in obtaining a channel of navigable width and about 10 feet depth through from Lake Michigan to Pine Lake, and in revetting both sides of the cut between Round and Pine lakes, the length of the revetment being on the north side 339 feet and on the south side 366 feet. The amount expended during the fiscal year ending June 30, 1888, was $7,368.38, including outstanding liabilities, and resulted in the construction of 354 feet of plank-beam revetment on the north side of channel, in the removal of 4,500 cubic yards of dredged material from the lower channel, and in the extension of the south pier 50 feet by a crib 20 feet wide.

The extension of the south pier is urgently needed to maintain a depth of 12 feet in the lower channel.

July 1, 1887, amount available	$10,289.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,368.38
July 1, 1888, balance available	2,920.80
Amount appropriated by act of August 11, 1888	12,500.00
Amount available for fiscal year ending June 30, 1889	15,420.80
Amount (estimated) required for completion of existing project	92,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 1.)

2. *Frankfort Harbor, Michigan.*—The natural channel of entrance to this harbor was not more than 3 to 4 feet deep. The present project for its improvement, adopted in 1866, was to dredge an outlet through a strip of land separating Lake Aux Becs Scies from Lake Michigan and to construct two parallel piers 200 feet apart extending from 12-feet soundings in the inner lake to the same depth in Lake Michigan. The amount expended to June 30, 1887, was $246,189.39, in securing an entrance 195 feet wide with an available depth of 12 feet. The amount expended during the fiscal year ending June 30, 1888, was $429.03, including outstanding liabilities, applied to contingencies of the work and office expenses. The amount available during the fiscal year was too small to undertake any work of pier extension.

The present available depth of water is 12 feet. Until the piers are extended into deeper water shoaling of the channel will continue to take place.

July 1, 1887, amount available	$3,748.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	429.03
July 1, 1888, balance available	3,319.93
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	11,319.93
Amount (estimated) required for completion of existing project	65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 2.)

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3. *Harbor of Refuge at Portage Lake, Michigan.*—No natural channel existed prior to the beginning of the improvement.

The project adopted in 1879 was to make this a harbor of refuge, with a channel 300 feet wide and not less than 18 feet deep. The piers as constructed, however, are 370 feet apart.

The amount expended to June 30, 1887, was $70,239.47 in revetting the north side of the channel, and the extension of the revetment by pile work and cribs into Lake Michigan 625 feet beyond the shore-line; also in building 137 feet of revetment on the south side, and in keeping open a narrow channel, by dredging, sufficient for local commerce. The amount expended during the fiscal year ending June 30, 1888, was $11,479.60, including outstanding liabilities, in removing 11,094 cubic yards of material with the Government dredge, and in extending the north pier 100.4 feet by two cribs 24 feet wide.

The present depth of water is 7.5 feet.

Until the piers are extended to a considerable distance no hope can be entertained of procuring a deeper channel than 8 feet.

July 1, 1887, amount available		$12,260.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$11,299.95	
July 1, 1888, outstanding liabilities	179.65	
		11,479.60
July 1, 1888, balance available		780.93
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,780.93
Amount (estimated) required for completion of existing project		172,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		60,000.00

(See Appendix I I 3.)

4. *Manistee, Harbor, Michigan.*—A narrow channel, not more than 8 feet in depth, was obtained at this harbor by the slab-piers built by local enterprise. The present project for improvement, adopted in 1866 and modified in 1870 and 1874, was to afford a channel of entrance of navigable width and not less than 12 feet deep.

The amount expended to June 30, 1887, was $225,108.12 in securing a channel of navigable width with an available depth of 12 feet.

The amount expended during fiscal year ending June 30, 1888, was $5,678.39, including outstanding liabilities, in extending the south pier 50 feet by a crib 30 feet wide.

The depth available is 12 feet.

July 1, 1887, amount available	$12,891.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,678.39
July 1, 1888, balance available	7,213.49
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	17,213.49
Amount (estimated) required for completion of existing project	82,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

(See Appendix I I 4.)

5. *Ludington Harbor, Michigan.*—The channel made by local enterprise was narrow and not more than 7 feet deep.

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The project for its improvement, adopted in 1867, was to afford a channel of entrance to Pere Marquette Lake, of navigable width, and not less than 12 feet deep.

The present project, approved January, 1885, is to widen the entrance to 400 feet by building a new south pier 400 feet south of the present north pier, and dredging the channel to a depth of 18 feet.

The amount expended to June 30, 1887, was $235,550.52, and has resulted in a navigable channel 200 feet wide and 15 feet deep.

The amount expended during the fiscal year ending June 30, 1888, was $1,506.67, including outstanding liabilities, in dredging a channel to a depth of 15 feet, removing 3,780 cubic yards.

The available depth of water is at present 15 feet.

July 1, 1887, amount available		$56,884.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$866.82	
July 1, 1888, outstanding liabilities	639.85	
		1,506.67
July 1, 1888, balance available		55,377.81
Amount appropriated by act of August 11, 1888		60,000.00
Amount available for fiscal year ending June 30, 1889		115,377.81
Amount (estimated) required for completion of existing project		303,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		120,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 5.)

Pentwater Harbor, Michigan.—The original channel of entrance was narrow and not more than 4 feet deep in its shoalest part.

The present project for its improvement, adopted in 1866, was to afford a channel of navigable width and not less than 12 feet deep.

The amount expended to June 30, 1887, was $209,791.74, and resulted in procuring a navigable channel 9 feet in depth.

The amount expended during the fiscal year ending June 30, 1888, was $2,813.48, including outstanding liabilities, in extending the south pier 53.8 feet by a crib 30 feet wide.

The present available depth, owing to the poor condition of the north pier at the shore end, which allows sand to enter the channel, is only 9 feet.

July 1, 1887, amount available		$8,028.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		2,813.48
July 1, 1888, balance available		5,214.78
Amount appropriated by act of August 11, 1888		8,000.00
Amount available for fiscal year ending June 30, 1889		13,214.78
Amount (estimated) required for completion of existing project		37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 6.)

7. *White River Harbor, Michigan.*—The old channel was narrow, crooked, and too shoal to accommodate any but very small vessels.

The present project for its improvement, adopted in 1866, was to afford a channel of navigable width not less than 12 feet deep.

The amount expended to June 30, 1887, was $237,274.96 and resulted in obtaining a channel of navigable width between 9 and 10 feet deep.

The amount expended during fiscal year ending June 30, 1888, was

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$7,699.98, including outstanding liabilities, in repairing the superstructure of a portion of the north pier, and in dredging 4,190 cubic yards of sand from the channel.

The present depth of water is 12 feet.

July 1, 1887, amount available		$10,275.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,245.95	
July 1, 1888, outstanding liabilities	1,465.71	
July 1, 1888, amount covered by existing contracts	988.32	
		7,699.98
July 1, 1888, balance available		2,575.06
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		12,575.06
Amount (estimated) required for completion of existing project		74,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 7.)

8. *Muskegon Harbor, Michigan.*—The original channel was irregularly defined by slab-piers, and while it gave comparatively fair access a bar at the end of the piers on which there was only 7 feet of water was an obstruction to navigation.

The project for improvement, adopted in 1866, was to obtain a channel of entrance of navigable width, and to extend the piers over the bar to 17-feet soundings.

The project was modified in 1880 so as to secure a width of entrance of 300 feet.

The amount expended to June 30, 1887, was $219,427.20, in securing a width of entrance of 300 feet, the main channel inside being 186 feet wide, with an available depth of 15 feet.

The amount expended during the fiscal year ending June 30, 1888, was $13,208.62, including outstanding liabilities, in repairing the end of the old north pier and in extending the north detached pier 100 feet by two cribs 30 feet wide.

The present available depth between piers is 15 feet, and over the bar beyond the piers it is 14 feet.

July 1, 1887, amount available		$14,572.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,194.53	
July 1, 1888, outstanding liabilities	14.09	
		13,208.62
July 1, 1888, balance available		1,364.18
Amount appropriated by act of August 11, 1888		45,000.00
Amount available for fiscal year ending June 30, 1889		46,364.18
Amount (estimated) required for completion of existing project		56,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		56,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 8.)

9. *Grand Haven Harbor, Michigan.*—The natural outlet was wide but shoal, the water being only 9 feet deep in the best course. The present project for improvement, adopted in 1866, was to obtain a channel of navigable width with a minimum depth of 18 feet.

The amount expended to June 30, 1887, was $486,434.93, in obtaining navigable channel 400 feet wide and 18 feet deep.

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The amount expended during the fiscal year ending June 30, 1888, was $27,024.05, including outstanding liabilities, and resulted in the addition of 150.6 feet of crib-work, 30 feet wide, to the north pier, and 52.2 feet of crib-work, of the same width, to the south pier, and in the repair of the old end crib of the south pier.

The present available depth of water between the piers is 18 feet, and over the bar outside 15 feet.

July 1, 1887, amount available		$37,931.22
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,901.05	
July 1, 1888, outstanding liabilities	123.00	
		27,024.05
July 1, 1888, balance available		10,907.17
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		35,907.17
Amount (estimated) required for completion of existing project		155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 9.)

10. *Black Lake Harbor, Michigan.*—The channel made by the Harbor Board of the city of Holland was narrow, irregular, and only 5½ feet deep.

The project for its improvement, adopted in 1866 and modified in 1873, was to obtain a channel of entrance of navigable width and not less than 12 feet deep.

The amount expended to June 30, 1887, was $252,854.26, in obtaining a channel 200 feet wide at the entrance and a depth of 10 feet.

The amount expended during the fiscal year ending June 30, 1888, including outstanding liabilities, was $4,237.24, in repairs to the superstructure of the north pile revetment.

The present available depth is only 7 feet, owing to a small shoal that has formed between the piers and the low stage of water in the lake.

July 1, 1887, amount available		$6,761.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,732.20	
July 1, 1888, outstanding liabilities	160.29	
July 1, 1888, amount covered by existing contracts	1,344.75	
		4,237.24
July 1, 1888, balance available		2,523.81
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		7,523.81
Amount (estimated) required for completion of existing project		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 10.)

11. *Saugatuck Harbor, Michigan.*—The channel, originally made by local enterprise, was narrow and not more than 7 feet deep in the best water.

The project for its improvement, adopted in 1869, was to obtain a channel of entrance of navigable width and an available depth of 10 feet.

The amount expended to June 30, 1887, was $124,790.48, in obtaining a narrow channel of 8 feet deep inside and 11 feet deep on the bar.

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The amount expended during the fiscal year ending June 30, 1888, was $9,665.15, including outstanding liabilities, and resulted in renewing the superstructure of 1,334 feet of the revetment on south side.

The present available depth of water is 8.5 feet.

July 1, 1887, amount available		$10,648.52
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,651.54	
July 1, 1888, outstanding liabilities	13.61	
		9,665.15
July 1, 1888, balance available		983.37
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,983.37

(See Appendix I I 11.)

12. *South Haven Harbor, Michigan.*—The channel, originally made by private enterprise, was narrow and not more than 7 feet in depth.

The present project for its improvement, adopted in 1866 and modified in 1879, was to obtain a channel of entrance of navigable width and not less than 14 feet deep.

The amount expended to June 30, 1887, was $172,218.06, in obtaining a channel of navigable width 11.5 feet between the piers and 14 feet on the bar.

The amount expended during the fiscal year ending June 30, 1888, was $9,761.99, including outstanding liabilities, and resulted in the extension of the south pier 53 feet by a crib 30 feet wide and in the removal of 1,750 cubic yards of material from the channel by dredging.

The present available depth of water is 10 feet.

July 1, 1887, amount available		$9,781.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,633.07	
July 1, 1888, outstanding liabilities	128.92	
July 1, 1888, amount covered by existing contracts		9,761.99
July 1, 1888, balance available		19.95
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,019.95
Amount (estimated) required for completion of existing project		67,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 12.)

13. *Saint Joseph Harbor, Michigan.*—The natural channel was originally about 250 feet wide and 12 feet deep at the entrance, shoaling to 9 feet in the river above.

The present project, adopted in 1866 and modified in 1874, was to obtain a channel of entrance of navigable width and not less than 16 feet deep.

The amount expended to June 30, 1887, was $337,568.43, in securing a channel of entrance 15 feet deep and a canal leading to Benton Harbor 100 feet wide and about 11 feet deep.

The amount expended during the fiscal year ending June 30, 1888, was $4,039.47, including outstanding liabilities, in repairs to the filling of the north revetment and to renewal of the superstructure of 476 feet of the south revetment; also in dredging 14,850 cubic yards from the canal and basin.

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July 1, 1887, amount available		$4,544.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,693.52	
July 1, 1888, outstanding liabilities	1,345.95	
		4,039.47
July 1, 1888, balance available		505.10
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		12,505.10
Amount (estimated) required for completion of existing project		29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix I I 13.)

14. *St. Joseph River, Michigan, from its mouth to Berrien Springs.*—This is a new work. An examination and survey of the river were made to comply with the requirements of the river and harbor act of March 3, 1879, and the report thereon is printed in the Report of the Chief of Engineers for 1880 as Appendix G G 20 (page 2049).

The proposed improvement contemplated the construction of wing-dams, dredging, and removal of snags and other obstructions, at an estimated cost of $11,300.

The river and harbor act of August 11, 1888, appropriates $2,500 for the work, and a further sum of $5,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$2,500.00
Amount (estimated) required for completion of existing project	8,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

15. *Michigan City Harbor, Indiana.—Outer Harbor.*—Work at this harbor was commenced by the Government in 1836. The project of 1857 for the construction of a breakwater had been modified, and in 1870 provided for pier extensions and dredging of channel. In 1870 provision was made for an exterior harbor, and in 1882 it was further modified and an exterior breakwater west of the harbor entrance and the construction of a pier at west end of exterior breakwater of outer harbor added.

The amount expended to June 30, 1887, was $830,396. With this amount the outer harbor has been completed with the exception of some dredging and the extension of the pier at its western extremity 350 feet. The depth of water is sufficient to admit the largest class of vessels on the lakes.

The amount expended during the fiscal year ending June 30, 1888, was $17,493.76, including outstanding liabilities, in rebuilding outer end of west pier and renewing its superstructure, and in repairs to the breakwater.

July 1, 1887, amount available		$38,397.59
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$17,268.05	
July 1, 1888, outstanding liabilities	225.71	
		17,493.76
July 1, 1888, balance available		20,903.83
Amount appropriated by act of August 11, 1888		90,000.00
Amount available for fiscal year ending June 30, 1889		110,903.83

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Amount (estimated) required for completion of existing project	$305,625.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix I I 14.)

Inner Harbor.—The site of the present inner harbor was originally a small creek, crooked, and with a depth insufficient for commercial purposes. The first project was that of 1870 for dredging up to the railroad bridge. In 1878 a modified project, providing for extending the inner harbor up Trail Creek by dredging, was adopted, the cut to be 120 feet wide and 15 feet deep, the city to revet the cut.

The amount expended to June 30, 1887, was $93,581.75 in dredging a navigable channel with a least depth of 13 feet.

The amount expended during the fiscal year ending June 30, 1888, was $314.68 in dredging 4,510 cubic yards from the channel.

The least depth of water up to the lower basin at end of year was 13 feet.

July 1, 1887, amount available	$3,293.25
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	314.68
July 1, 1888, balance available	2,978.57
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	7,978.57

(See appendix I I 14.)

IMPROVEMENT OF ST. MARY'S RIVER—ENLARGEMENT OF AND OPERATING ST. MARY'S FALLS CANAL—CONSTRUCTION OF HARBOR OF REFUGE ON LAKE HURON, AND IMPROVEMENT OF CERTAIN HARBORS ON LAKE HURON AND OF SAGINAW RIVER—PRESERVATION OF AND OPERATING ST. CLAIR FLATS CANAL—IMPROVEMENT OF GROSSE-POINT CHANNEL AND OF DETROIT RIVER.

Officer in charge, Lieut.-Col. O. M. Poe, Corps of Engineers, with Lieut. H. F. Hodges, Corps of Engineers, under his immediate orders.

1. *St. Mary's Falls Canal and River, Michigan.*—The project for obtaining a navigable channel of 16 feet in depth between Lakes Superior and Huron had been barely completed when the demands of commerce so enormously increased that the work of attaining a depth of 20 feet throughout was undertaken with the full sanction of both legislative and executive authority.

A necessary part of the project is the construction of a new lock upon the site of the old State locks, to have a length of 800 feet between gates, a width of 100 feet throughout, a depth of 21 feet on the miter-sills, and a single lift approximating 18 feet. The canal is to be deepened to correspond. The estimated cost of this enlargement of the canal system is $4,738,865, for the details of which see pages 2220 *et seq.* of the Annual Report of the Chief of Engineers for 1887. The statistics of the commerce using the canal indicate more clearly each succeeding year the urgency for rapid progress in the improvement. It is now so great that an estimate of $1,500,000 is submitted for the prosecution of the work during the fiscal year ending June 30, 1890, in full confidence that the actual conditions now existing will justify so large an appropriation.

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July 1, 1887, amount available		$227,909.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$112,508.72	
July 1, 1888, outstanding liabilities	24,432.48	
July 1, 1888, amount covered by existing contracts	90,968.22	
		227,909.42
Amount appropriated by act of August 11, 1888		1,000,000.00
Amount (estimated) required for completion of existing project		3,738,865.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J J 1.)

2. *Operating and care of Saint Mary's Falls Canal, Michigan.*—During the fiscal year the canal was open to navigation two hundred and ten days. It was closed for the winter December 2, 1887, and opened May 7 for the season of 1888.

Eight thousand eight hundred and twenty-three vessels, etc., representing a registered tonnage of 4,741,976 tons, and carrying 5,581,169 tons of freight and 29,494 passengers, passed through in 3,940 lockages.

The staple articles transported were 1,605,279 tons of coal, 31,868 tons of copper, 1,645,236 barrels of flour, 23,049,421 bushels of grain, 2,328,275 tons of iron ore, 63,571 tons of pig and manufactured iron, 201,922 barrels of salt, 1,168 tons of silver ore, 188,228,000 feet B. M. of lumber, 20,404 tons building stone, 2,215 tons of wool, 310 tons of hides, and 347,275 tons of unclassified freight.

The expenditures on account of operating and care for the fiscal year aggregated $29,898.72, and the receipts for dry-docking were $844. The difference, $29,054, was therefore the net cost to the United States.

The estimated amount required for the fiscal year ending June 30, 1889, is $36,000, all of which is already provided for by indefinite appropriation.

Amount required for fiscal year ending June 30, 1889		$36,000.00
Balance remaining in hand from allotment of preceding year, exclusive of outstanding liabilities		1,101.28
Additional allotment required for fiscal year ending June 30, 1889		34,898.72

A balance ($22,173.41) remained undrawn from the allotment for the fiscal year ending June 30, 1888, and $1,040 remained undrawn of the allotment for the fiscal year ending June 30, 1887.

(See Appendix J J 2.)

3. *Dry-dock at Saint Mary's Falls Canal, Michigan.*—There is nothing to add to the subject-matter of preceding reports in regard to this work beyond the fact that the construction of the coffer-dam inclosing the site of the proposed lock at Saint Mary's Falls Canal has reached that stage which renders necessary the tearing out of the walls of the old lower lock, and therefore all projects aiming at converting the old State locks into a dry-dock must be considered as disposed of.

The proposition to locate a dry-dock in immediate proximity to the lockage system is as objectionable as ever; but if it should be decided to do so, then the location heretofore referred to at the eastern end of the area transferred from the Fort Brady military reservation to the canal reservation is the least objectionable.

Amount (estimated) required for construction of a dry-dock at point indicated	$323,872
Amount that can be profitably expended in fiscal year ending June 30, 1890	150,000

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which should be added to the $65,000 (more or less) which it is understood the State of Michigan holds in readiness to transfer to the United States for the purpose of constructing a dry-dock at Saint Mary's Falls Canal.

(See Appendix J J 3.)

4. *Hay Lake Channel Saint Mary's River, Michigan.*—The original estimates for this improvement were based upon a project for a channel 300 feet wide, 17 feet deep, leaving the present navigable channel of Saint Mary's River at Sugar Island Rapids (about 3¼ miles below the canal), through these into Hay Lake, and then, by way of the Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles and obtaining a route which it is practicable to so mark with lights as to be navigable at night—a condition impracticable with the present route.

The estimated cost of this project was $2,127,292. The project was subsequently modified to increase the depth to 20 feet, the estimate of cost being $2,659,115, subject to change, however, in case unexpected difficulties are developed during the progress of the work.

The amount thus far appropriated for the work is $475,000, all of which has either been expended or is covered by existing contracts, and has been or is to be applied to excavation in Middle Neebish, except a comparatively small amount expended in surveys and examinations at Sugar Island Rapids, and in surveys and excavations at Sailor's Encampment.

The work is progressing well, and with ample appropriations could be pushed with great energy. The length of the route is sufficient to admit of the use of a very extensive plant, and bearing in mind the fact that the channel is not available until the whole is completed, the appropriation of $500,000 for the fiscal year ending June 30, 1890. is strongly urged.

July 1, 1887, amount available		$152,540.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$72,005.08	
July 1, 1888, outstanding liabilities	6,941.77	
July 1, 1888, amount covered by existing contracts	73,593.44	
		152,540.29
Amount appropriated by act of August 11, 1888		500,000.00
Amount (estimated) required for completion of existing project		1,684,115.00
Amount that can be profitably expended in the fiscal year ending June 30, 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J J 4.)

5. *Harbor at Cheboygan, Michigan.*—Prior to undertaking any improvement at this harbor only 6½ to 7 feet of water could be carried across the bar at the mouth of Cheboygan River.

The original project for the improvement, adopted in 1871, contemplated dredging a channel 200 feet wide and 14 feet deep through the bar, and revetting each side by a pile-pier. Experience gained during the progress of the work already done leads to the belief that the piers can be dispensed with, with consequent reduction of cost to the extent of about one-half the original estimate.

Subsequent modifications of the project were made until, as it now stands, it provides for a channel of 15 feet in depth, and generally of 200 feet in width, from the 15-foot curve in Straits of Mackinac to the State Road Bridge.

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The contract in force at the date of the annual report for last year resulted in much greater progress than had been expected, and when the work covered by it was completed the improvement had been carried so well up-stream that but about 45,000 cubic yards remain to be removed to complete the channel to the State Road Bridge, the limit of the existing project, and the cost was entirely paid from prior appropriations, leaving the appropriation of August 5, 1886, untouched.

A contract has been made for the remainder of the required excavation at a price so low that the funds available will suffice to pay for all that is proposed at present, and therefore no further estimate is submitted at this time. It is feared, however, that the contractor may not be able to do the work at the price of his contract, and that failure may result. In that case it may be necessary in the future to estimate for further appropriations.

July 1, 1887, amount available		$19,291.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,976.08	
July 1, 1888, amount covered by existing contracts	14,315.12	
		19,291.20
Amount appropriated by act of August 11, 1888		15,000.00
Amount (estimated) required for completion of existing project		70,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix J J 5.)

6. *Harbor at Thunder Bay, Michigan.*—The project for the improvement of this harbor was adopted in 1876, the object being to obtain an entrance channel from the bay into the river of navigable width and of not less than 13 feet in depth. The project was subsequently modified to such extent as to provide for a depth of 14 feet.

This had been practically accomplished at the date of the Annual Report for 1884. It was then stated that the improvement was of such a character that it would require attention from time to time, and it was recommended that a sufficient appropriation be made to render available the sum of $10,000 for use when it should be wanted. This was not done, however, and the matter has remained in abeyance.

Recent complaints of insufficiency of water arise from these causes:

(1) Deterioration of depth (due to deposits).

(2) A low stage of water in Lake Huron.

(3) The general use of larger vessels.

It is estimated that to fully restore the 14-foot channel will require an additional appropriation of $5,489.09, thus making available the sum of $10,000.

The commerce of the harbor last season, as reported by the deputy collector of customs, amounted to 750,000 tons, having a value of $5,267,000. A demand for a 16-foot navigation has arisen in consequence, and is well worthy of consideration. It is therefore recommended that the additional sum of $30,000 be appropriated for the latter purpose, thus making the entire sum available $34,510.91, all of which can be profitably expended in one year.

July 1, 1887, amount available	$4,525.07
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14.16
July 1, 1888, balance available	4,510.91

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Amount (estimated) required for completion of proposed project	$30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 6.)

7. *Harbor at Au Sable, Michigan.*—The present project for the improvement of this harbor was adopted in 1866, and modified in 1879, the object being to obtain a channel of not less than 10 feet in depth for a width of 100 feet from the lake to the State Road Bridge at Au Sable.

The attempts to improve this harbor have not been as successful as had been hoped, and it does not appear practicable to make any permanent improvement at a cost commensurate with the advantages to be gained. Therefore no estimate is submitted for a further appropriation at this time.

July 1, 1887, amount available	$4,861.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	15.76
July 1, 1888, balance available	4,845.77

(See Appendix J J 7.)

8. *Saginaw River, Michigan.*—The present project aims to secure a channel 200 feet wide, 14 feet deep, from Saginaw Bay to Bay City, and 12 feet deep thence to the head of navigation in Saginaw River, a total distance of about 23 miles.

By the river and harbor act of August 5, 1886, the improvement of the west channel of Saginaw River, along West Bay City, was added to the original project.

The same act appropriated the sum of $33,750 for "continuing improvement, * * * of which $16,875 are to be used above Bay City, and $5,000 in improving the west channel along West Bay City."

The works reported in progress last year were all carried as far as practicable with the funds available.

Above Bay City.—Repairs of beam-wall and revetment at Carrollton for a total linear distance of 4,239 feet, involving the drawing and redriving of 242 old piles, driving 817 new piles, and the use of 325 cords mill edgings for filling; total expenditures during fiscal year $10,410.29.

Opposite and below Bay City.—Operations were confined to dredging on the bar at the mouth of the river, resulting in the removal of 18,477 cubic yards of material at a cost of $8,222.26.

West Channel along West Bay City.—A channel 1,830 feet long, 12 feet deep, and 25 feet wide, was dredged along the west line of the proposed channel below the "Cincinnati Mill" dock and in front of Davidson's ship-yard. In addition the shoal immediately above the Portsmouth Bridge was almost entirely removed. The total excavation amounted to 12,520 cubic yards at a total cost of $3,756.

The available funds are practically exhausted. The interests involved are so large as to justify the most extensive operations, and the length of the channel (nearly 23 miles) is such that they can be readily carried on without interfering with each other.

The estimate covers $157,050, which includes $20,000 for the West Channel along West Bay City, which forms no part of the original project. The amount of the estimate applicable to the original project is therefore $137,050.

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July 1, 1887, amount available	$26,352.12
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	25,277.99
July 1, 1888, balance available	1,074.13
Amount appropriated by act of August 11, 1888	65,000.00
Amount available for fiscal year ending June 30, 1889	66,074.13
Amount (estimated) required for completion of existing project	272,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	137,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 8.)

9. *Harbor of Refuge at Sand Beach, Lake Huron, Michigan.*—The present project for this improvement was adopted in 1873. It consists of a breakwater constructed of timber cribs filled with stone, inclosing an area which is to be deepened by dredging where necessary.

Its object is to afford a harbor of refuge to vessels engaged in the navigation of the northern and northwestern lakes when caught in heavy weather near the dangerous Pointe aux Barques, the southerly headland of the mouth of Saginaw Bay. Prior to 1876 vessels so caught were compelled to run a distance of 60 miles to find refuge in Saint Clair River; after the subsidence of the gale those upward bound had to work their way back again. Few improvements have resulted in greater benefit to the lake commerce, as is fully shown by the infrequency of disasters in the vicinity since it became available.

The estimate of the probable cost of the improvement was $1,442,500. The sum of $1,050,000 has been appropriated for the work, but of this amounts aggregating $75,000 have been expended for operating the harbor and for repairs rendered necessary by extraordinary circumstances, etc., none of which were contemplated when the original estimate was made, so that the amount actually applied in accordance with the original project has been about $975,000.

If sufficient in amount, the next appropriation should be expended in beginning the construction of a permanent superstructure, for current repairs, for custody and control of the harbor for one year, and for dredging in and about the harbor.

July 1, 1887, amount available		$35,575.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$19,766.35	
July 1, 1888, outstanding liabilities	4,397.31	
July 1, 1888, amount covered by existing contracts	11,411,94	
		35,575.60
Amount appropriated by act of August 11, 1888		70,000.00
Amount (estimated) required for completion of existing project		58,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		58,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J J 9.)

10. *Mouth of Black River, Michigan.*—To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination, a survey being unnecessary, was made of the above, and the report thereon is printed in the Report of the Chief of Engineers for 1887 as Appendix K K 22.

The improvement proposed is the removal by dredging of all material at the mouth of the river above the uniform depth of 17 feet, at an estimated cost of $59,300.

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Under previous appropriations, the last made in 1876, aggregating $56,500, the shoal was removed to a depth of 16 feet.

The river and harbor act of August 11, 1888, appropriates $10,000 for the work, and a further sum of $20,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	59,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

11. *Clinton River, Michigan.*—In 1870 the channel over the bar at the entrance to this river afforded a depth of only 3½ feet, whilst the depth in the river some distance above the bar was 10 feet.

The present project for improvement was adopted in 1870 and modified in 1880. It aims to obtain an entrance channel of 8 feet. This was practically accomplished in 1882.

In a report of January, 1885, of the results of a survey made to comply with provisions of the river and harbor act of 1884, a modification of the existing project was proposed by the officer in charge, involving the straightening of the channel of the river at Shoemaker's Bend, and minor improvements elsewhere, at a cost of $33,000

This report was transmitted to Congress February 11, 1885, and the river and harbor act of August 5, 1886, appropriated $6,000 for continuing the improvement.

This amount being too small to accomplish anything at the mouth of the river and at Shoemaker's Bend has not been expended, and is held to await future action of Congress.

Meanwhile an unusually low stage of water has occurred, resulting in great difficulty in navigating the river. Consequently, urgent demand was made for temporary relief, and the expenditure of $2,500 in dredging for the purpose has been authorized, and the work is now in progress. This will reduce the amount available for the existing project to $3,500, to which adding the $10,000 appropriated by act of August 11, 1888, leaves a balance of $19,500 yet to be provided.

July 1, 1887, amount available		$6,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$81.88	
July 1, 1888, outstanding liabilities	610.50	
July 1, 1888, amount covered by existing contracts	1,807.62	
		2,500.00
July 1, 1888, balance available		3,500.00
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		13,500.00
Amount (estimated) required for completion of existing project		19,426.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		19,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix J J 12.)

12. *Saint Clair Flats Canal, Michigan.*—This canal was projected in 1866, with a view to obtaining a straight channel 13 feet deep and 300 feet wide across Saint Clair Flats, the channel being bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet.

These dikes consist of timber cribs resting upon piles driven into the original bottom of the shoal, the crib-pockets being filled with material dredged from the channel. To maintain a channel bank a single row of sheet-piling was driven along the channel-face of the cribs previous

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to dredging. The lake-sides of the dikes were protected from wave action by shorter sheet-piling.

In 1873 the channel was deepened to 16 feet by dredging for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all, being thus limited by the fact that the sheet-piling, intended for a depth of 13 feet, have not sufficient penetration to admit of dredging to 16 feet for the full width of 300 feet. Moreover, the single row of sheet-piling is insufficient to prevent the leakage of the dike material through it into the channel, and it is necessary to re-enforce it with a double row, giving them, however, sufficient penetration to admit of subsequent dredging to a depth of 20 feet.

The entire timber superstructure is much decayed, and should be renewed as soon as possible. Its condition has been duly reported in the Annual Reports for the last four or five years, and the condition becomes worse with each succeeding year. It has now been in place for an average of about twenty years.

The present project for improving the canal contemplates driving a double row of sheet-piling to a depth of 26 feet along the channel-face of each dike, dredging the area between them to a depth of 20 feet, continuing the channel above and below the canal to the same depth in river and lake, and rebuilding the wooden superstructure.

The cost of the work indicated, exclusive of dredging, is estimated at $200,000, an increase of nearly 33 per cent. upon the estimate submitted in 1885. This increase arises from the continued increase in the price of labor and materials, especially of timber, which forms so large a portion of the latter. It is probable that, for the reason stated, this estimate will have to be increased from time to time, depending upon the extent of the delay.

By the river and harbor act of August 5, 1886, the sum of $18,750 was appropriated for continuing the improvement. This has been expended in the construction of 2,449 linear feet of re-enforcing sheet-piling.

July 1, 1887, amount available	$18,553.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	18,414.24
July 1, 1888, balance available	139.70
Amount appropriated by act of August 11, 1888	75,000.00
Amount available for fiscal year ending June 30, 1889	75,139.70
Amount (estimated) required for completion of existing project	181,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 13.)

13. *Operating and care of Saint Clair Flats Canal, Michigan.*—The canal is in immediate charge of a custodian, who also acts as inspector whenever any work is in progress.

During the past year operations were limited to the necessary supervision of the canal, and the expenditures to the custodian's salary of $1,500, and to the repairs of the boat belonging to the work, amounting to $10, or an aggregate of $1,510.

The estimated cost of operating and care of the canal for the fiscal year ending June 30, 1889, is as follows:

Salary of custodian	$1,500
Current repairs and contingencies, which can neither be foreseen nor estimated for in detail, to include a fair proportion of the office of the superintending engineer at Detroit	3,500
Total	$5,000

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All of which is provided for by indefinite appropriation (section 4 of the river and harbor act of June 5, 1884).

Amount required for fiscal year ending June 30, 1889	$5,000.00
Balance remaining "in hand" from allotment of preceding year, exclusive of outstanding liabilities	391.93
Additional allotment required for fiscal year ending June 30, 1889	4,608.07

A balance of $4,500 remained undrawn from the allotment for the fiscal year ending June 30, 1888, and $7,000 for the fiscal years ending June 30, 1886 and 1887.

(See Appendix J J 14.)

14. *Grosse Point Channel, Michigan.*—Within the last two or three years a good deal of trouble has occurred to vessels because of insufficiency of water in the channel off Grosse Point, Mich., at the lower end of Lake Saint Clair (head of Detroit River). The improvement of this channel has always formed a part of the project for the amelioration of the general navigation of the Lakes, and now that the use of vessels of heavier draught has become so common, and the mishaps, and consequent expense and delay to which they are almost daily subjected at this place have become so great a burden, the work of improvement should be no longer delayed.

The improvement proposed for the present consists in dredging the present channel sufficiently to give a depth of 19½ feet for a width of 800 feet. This was submitted to Congress in Senate Ex. Doc. No. 82, Fiftieth Congress, first session. The amount of material to be removed to make such a channel is about 2,515,000 cubic yards, and the cost is estimated at $553,300, and an estimate of $200,000 is submitted with which to begin the work.

The tonnage passing this point amounts to about 20,000,000 per year.

The act of August 11, 1888, appropriated $75,000 for continuing the improvement of Saint Clair Flats Ship Canal, with a proviso that all or any portion of which may be expended in dredging Grosse Point Channel.

Amount (estimated) required for completion of proposed project	$553,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix J J 15.)

15. *Detroit River, Michigan.*—Originally the channel at Lime Kiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depth being much affected by the direction of the wind.

As originally projected in 1874, the improvement at this point was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the original estimate was based upon this project.

In 1883 it was determined to so modify the project as to secure a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done.

In 1886 this was further modified to the end that the width of the channel should be increased to 400 feet by removing an additional width of 100 feet from the western (American) side.

From the beginning of the fiscal year operations were energetically prosecuted until September 15, 1887, when they were suspended because of the exhaustion of the available funds.

The progress proposed to be made with the appropriation of August

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5, 1886, has been fully accomplished. About seven-twelfths of the material has been removed from the additional 100 feet in width required to make the channel 400 feet wide according to the project of 1886.

July 1, 1887, amount available	$8,991.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,830.75
July 1, 1888, balance available	160.52
Amount appropriated by act of August 11, 1888	130,500.00
Amount available for fiscal year ending June 30, 1889	130,660.52

(See Appendix J J 16.)

16. *Rouge River, Michigan, at its junction with Detroit River and up the river as far as the bridge of Saint Louis and Wabash Railroad.*—This is a new work. In compliance with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Rouge River, and the report thereon is printed in the Report of the Chief of Engineers for 1887 as Appendix K K 21 (page 2275).

The proposed improvement contemplates the forming of a channel 16 feet deep and 240 feet wide at mouth of the river and for a distance of 800 feet above and then decreasing to 100 feet in width to the bridge of the Saint Louis and Wabash Railroad, at an estimated cost of $31,690.39.

The river and harbor act of August 11, 1888, appropriates $10,000 for the work, and $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	21,690.39
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

IMPROVEMENT OF HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA—IMPROVEMENT OF SANDUSKY RIVER.

Officer in charge, Maj. L. Cooper Overman, Corps of Engineers.

1. *Monroe Harbor, Michigan.*—The original project for the improvement of this harbor was adopted in 1835, when Monroe was a town of considerable importance, and when the navigable waters of the River Raisin were separated from the waters of Lake Erie by extensive shoals. It provided for cutting a canal between the river and the lake, 4,000 feet long and 10 feet wide, through River Raisin Point, and protecting the entrance into the lake by parallel piers, the object being to afford a channel of entrance of navigable width, with a depth of 10 feet. Work was commenced in 1835 and has been continued from time to time since that date.

At the close of the last fiscal year there was a fair channel with a least depth of 8 feet, up to a point below Monroe where rock bottom exists, which is deemed sufficient for the present commerce of the port.

During the month of July, 1887, the sum of $371.94 was expended in repairs in accordance with terms of the appropriation, being the balance of funds on hand. No other work was done during balance of the fiscal year.

The total amount appropriated for this harbor has been $215,515.27.

If the harbor is to be kept up there is need of extensive repairs to

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piers and canal revetment, in order to prevent their ultimate destruction. These are estimated to cost $20,000.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project and repairs	21,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 1.)

2. *Toledo Harbor, Ohio.*—The original project provided for making the existing channel 200 feet wide and 12 feet deep through Maumee Bay, and this was amended from time to time, resulting in the adoption of the present project, which provides for a width of 200 feet at bottom and a depth of 16 feet at low water between the city of Toledo and deep water in Lake Erie.

The total amount appropriated for this harbor for the several projects for improving the natural channel, from 1866 to close of fiscal year ending June 30, 1888, is $714,046.71, all of which has been expended, and has resulted in obtaining a 15½-foot channel where before there was a narrow, intricate channel with but 11 feet depth.

The act of August 5, 1886, appropriated for "continuing the improvement of Maumee River by a straight channel along such line as may be approved by the Secretary of War, $112,500; and the balance of the $25,000 heretofore appropriated are hereby made available for clearing the old channel."

The balance then available amounted to $9,632.61. A contract was made for dredging to the extent of available funds for clearing the old channel. This was completed in May, 1887, only 45,397 cubic yards were removed. This quantity did not restore the natural channel to its condition as at close of 1885, as the annual fill exceeds 50,000 cubic yards.

The estimated cost of the present project for the natural channel was $570,000, of which amount there has been appropriated $519,346.91. The balance of $50,000 yet required will not complete the project as originally estimated, owing to the time consumed in doing the work for want of adequate appropriation; the annual removal of the deposits of each winter and spring repeated for thirteen years, and other necessary expenses, having absorbed at least $100,000 of the original estimate. It will therefore require at least $100,000 to complete the deepening and widening of the natural channel between Toledo and 16 feet of water in Lake Erie, after which an annual expenditure of about $20,000 will be needed to maintain the dredged channel through the open bay, or until the straight channel improvement is completed.

The act of July 5, 1884, appropriated $25,000 to commence the work of making a straight channel for the Maumee River from its mouth to Lake Erie.

The sum of $15,367.39 was expended in dredging along a line designated by this act of Congress, but subsequently abandoned.

To comply with the requirements of the act of August 5, 1886, additional examinations became necessary to determine the line to be recommended for approval of the Secretary of War. These were made and the report of the officer in charge thereon was referred to a Board of Engineer Officers for consideration. The Board adopted a line different from all others previously selected, which was approved by the Secretary of War, April 27, 1887.

A project for the expenditure of the appropriation of 1886, in accord-

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ance with this report of the Board of Engineers, was adopted, and contracts were made for dredging about 750,000 cubic yards along the projected straight channel.

Work has been carried on under these contracts during the fiscal year. About 428,913 cubic yards of material have been excavated and removed from along a section of the line of proposed straight channel, but the small amount of work done, as compared with the entire project, is of no avail.

There have been two appropriations for straight channel, amounting to $137,500, of which $84,730.20, including outstanding liabilities, has been expended to June 30, 1888 (on two lines), and $9,632.61 transferred to "old channel."

Straight channel.

July 1, 1887, amount available		$109,178.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$49,517.89	
July 1, 1884, outstanding liabilities	16,237.87	
July 1, 1888, amount covered by existing contracts	42,400.00	
		108,155.76
July 1, 1888, balance available		1,022.89
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		151,022.89
Amount (estimated) required for completion of existing project		1,262,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Old channel.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount that can profitably be expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 2.)

3. *Port Clinton Harbor, Ohio.*—In 1870 the channel at the entrance was narrow and intricate, with a depth of only 5 feet.

The present project, adopted in 1875, provides for a pile revetment from the north shore of the Portage River, opposite the town, 967 feet into the lake, and two pile-piers, 200 feet apart, of an aggregate length of 4,100 feet, extending to the depth of 10 feet in the lake, with a view of maintaining a depth of 9 feet between them.

The act of August 5, 1886, appropriated $2,000 for "repairs of existing works," and at the close of the year 1887 had been expended in making the most urgent of the repairs. Considerable repairs are still required and dredging also is badly needed.

The total amount appropriated for this harbor to the close of the fiscal year ending June 30, 1888, has been $48,000, all of which has been expended, and has resulted in obtaining a depth of 8 feet from the lake to the town. The proposed improvement is only about one-half finished.

July 1, 1887, amount available	$1,960.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,960.66
Amount appropriated by act of August 11, 1888	5,000.00

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Amount (estimated) required for completion of existing project	$37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 3.)

4. *Sandusky City Harbor, Ohio.*—The original depth in the channel through the outer bar was 10 feet, and greatest depth in the bay about 12 feet.

The project adopted in 1880 provides for a channel through the outer bar and through the bay 200 feet wide, and parallel to the city docks 100 feet wide, the whole to be 15 feet deep.

An increased depth of 16 feet at low water in the old channel is recommended for this harbor by the officer in charge, on account of the increased size of vessels navigating the lakes. The estimated cost of this extra depth is $61,000.

A project for "a straight channel" for this harbor, extending from the east end of the dock channel to the north end of Cedar Point, has received the sanction of Congress. This will materially shorten and improve the existing entrance. The estimated cost is $96,712, an increase of only $46,712 over the estimate for the project of 1880 as revised to give 16 feet depth.

Under the appropriation of August 5, 1886, a contract was made for dredging to the extent of the available funds. Work was commenced in November, 1886, and was being continued at the close of the fiscal year with but little progress by the contractor; 17,036 cubic yards of material were removed from the channel, which restored it to a condition similar to that at close of 1887.

An annual removal of at least 10,000 cubic yards is necessary to maintain the unfinished channel, after which the additional dredging can be applied toward the completion of the channel to 200 feet in width and 15 feet in depth.

The appropriation asked will complete the project of 1880, but not the revised project for increased depth.

At the close of the fiscal year ended June 30, 1888, the sum of $263,715.47, exclusive of outside liabilities and existing contracts, had been expended on this harbor, resulting in a channel through the outer bar about 150 feet wide, having a depth of about 15 feet, in which for a width of 50 feet there was a depth of 16½ feet, and through the bay up to a point 50 feet from the line of docks a width of 150 feet and depth of about 14½ feet.

July 1, 1887, amount available		$12,337.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,972.81	
July 1, 1888, outstanding liabilities	2,565.40	
July 1, 1888, amount covered by existing contracts	3,150.00	
		11,688.21
July 1, 1888, balance available		649.13
Amount appropriated by act of August 11, 1888		40,000.00
Amount available for fiscal year ending June 30, 1889		40,649.13

Amount (estimated) required for completion of existing project	67,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	45,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 4.)

5. *Sandusky River, Ohio.*—The present project, which was based on a survey made in compliance with the river and harbor act of 1880, pro-

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vides for opening a channel 100 feet wide and 9 feet deep between the town of Fremont and the depth of 9 feet in Sandusky Bay, at an estimated cost of $44,000.

During the years 1867 and 1872 the sum of $30,000 was expended in opening a navigable channel with a depth of 8 feet from Sandusky Bay to Fremont, a distance of 17 miles. Since 1872 the cuts then made through the various bars have filled up.

At the close of the fiscal year ending June 30, 1883, the sum of $21,500 had been appropriated for the present project, of which amount $20,871.53 have been expended; and there was at the close of the season of 1883 a good channel, with least depth of 9 feet, from Fremont, the head of navigation, to the lake. The last appropriation for this river was that of August 2, 1882.

The balance on hand, viz, $628.47, was too small to attempt any further work last season.

Up to the present date $51,500 has been appropriated for this river, of which sum $50,871.53 has been expended.

July 1, 1887, amount available	$628.47
July 1, 1888, balance available	628.47
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	22,500.00

(See Appendix K K 5.)

6. *Huron Harbor, Ohio.*—At the close of the fiscal year ending June 30, 1887, there was a good channel through the outer bar with a depth of 16½ feet, and between the piers with a depth of from 16 to 17 feet. The superstructure of both piers, except where repaired in 1884 and 1886, was in a decayed condition and needed immediate renewal.

The heavy gales of the springs of 1885, 1886, 1887, and 1888 did considerable damage to the piers and to the beaches, so that a breach was made at the inner end of east pier near the shore. Extensive and immediate repairs are much needed.

Up to the end of the fiscal year the sum of $117,273.71 has been appropriated for this harbor, all of which has been expended, including the last appropriation, that of August 5, 1886.

A good channel, with least depth of 14 feet, had been obtained, until piers became dilapidated, where originally there was a sand-bar dry at low water.

The estimated cost of renewing the superstructure of the piers is $22,000; $13,500 has been appropriated. Repairs in addition to those contemplated when the estimate was submitted have been made necessary by the storms of 1884, 1885, 1886, 1887, and 1888, and the amount asked for to completely renew the piers has been correspondingly increased.

Amount appropriated by act of August 11, 1888	$6,000.00
Amount (estimated) required for completion of existing project and repairs	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 6.)

7. *Vermillion Harbor, Ohio.*—Before improvement the mouth of the Vermillion River was closed by a sand-bar, upon which there was a depth of less than 2 feet; the original project consisted of parallel piers

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running out into the lake from each side of the mouth of the river, in in order to secure a depth of 10 feet. This project has been amended from time to time, and now provides for a depth of 14 feet.

In 1878 the channel was about 70 feet wide, with a depth of about 12 feet, and has since remained nearly permanent.

The act of August 5, 1886, made an appropriation of $3,000 for this harbor. Only partial repairs to the piers could be made with the small amount of funds available, which repairs were made during the fall of 1886.

At the close of the fiscal year ending June 30, 1888, the piers were in fair condition; the depth in channel was about the same as at close of the previous fiscal year. The amount appropriated to close of fiscal year ending June 30, 1888, has been $117,942.32, all of which sum has been expended.

July 1, 1887, amount available	$308.18
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	308.18
Amount appropriated by act of August 11, 1888	1,000.00
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,000.00

(See Appendix K K 7.)

8. *Black River Harbor, Ohio.*—The present project for the improvement of this harbor consists of parallel piers 200 feet apart, running out to a depth of 16 feet in the lake.

Up to the close of the fiscal year ending June 30, 1888, there had been appropriated, since 1826, the sum of $210,138.73, all of which has been expended, and with which a channel with least depth of 16 feet has been obtained where originally there was but 3 feet at the entrance.

The act of August 5, 1886, appropriated $10,000 for this harbor. A contract was at once made for the dredging necessary to remove a shoal that had formed beyond the piers, and the 16-foot channel was restored by the end of September, 1886. The repair of piers under contract was begun in November, 1886, and at the end of August, 1887, were finished and appropriation exhausted. The piers need considerable renewal of superstructure.

Nothing has been accomplished towards the extension of the piers, which is the most important work when funds sufficient shall be available.

The unexpected and extra repairs made and to be made at this harbor will increase the estimate for repairs, and the renewal and the prolonging of the piers will cost at least $12,000, so that the sum of $20,000 is still needed to complete the existing project.

July 1, 1887, amount available	$5,498.99
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,498.99
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix K K 8.)

9. *Rocky River, Ohio.*—The project for the improvement of this river was adopted in 1871, the object being to afford a channel of entrance

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100 feet wide and from 6 to 12 feet deep. It required the construction of a pier 500 feet long, and a large amount of excavation.

With the appropriations of 1872, 1874, and 1875, amounting to $35,000, the pier as projected was constructed, but only a small amount of excavation was done.

By the act of June 14, 1880, $4,000 was appropriated for repairs, and during the years 1880 and 1881 portions of this amount were expended in placing the piers in good condition. The storms of 1883 did considerable damage, and it was repaired during the fiscal year ending June 30, 1884, at a cost of $1,248.61. At the close of that season the pier was in fair condition, but the storms of the springs of 1884, 1885, 1886, 1887, and 1888 have again damaged it, and very extensive repairs are now needed. As the act of August 5, 1886, made no appropriation for this harbor, and the balance on hand is too small to attempt any repairs, there will be no work practicable until further appropriation, and the damaged pier will be still further impaired. No work was done nor expenditure of any sort made during the fiscal year ending June 30, 1888.

July 1, 1887, amount available	$119.31
July 1, 1888, balance available	119.31

(See Appendix K K 9.)

10. *Cleveland Harbor, Ohio.*—The original project for the improvement of the mouth of Cuyahoga River was adopted in 1825, and has been amended from time to time to gain increased depth. It consists of parallel piers about 200 feet apart, running out to a depth of 16 feet in the lake.

When operations were commenced there was a long, low sand-bar where the river now empties into the lake, and the entrance was through a narrow, intricate channel with a depth of about 3 feet.

At the close of the fiscal year ending June 30, 1888, there had been expended about $369,500, and there was, as a result, a good, wide channel at the entrance of the harbor, with a depth of from 14 to 18 feet between the lake and the railroad bridge at the inner end of the piers, with a pile protection work 620 feet long at the inner end of the west pier, constructed in 1882.

Harbor of Refuge.—The original project provided for on outer breakwater, starting from the lake shore about 700 feet west of the upper end of the old river-bed.

The west breakwater runs out about due north a distance of 3,130 feet to a depth of 28 feet, and thence for 4,030 feet it runs nearly parallel to the shore, with a spur 100 feet long on the north side of the lake arm, 200 feet from its eastern end, in a depth of from 28 to 30 feet. It was originally proposed to protect the entrance to the harbor on the east side by extending the east pier at the mouth of the river 1,400 feet.

An amended project changed this plan and provided for a breakwater on the east side, which begins at a point on the prolongation of the arm of the west breakwater and 500 feet from it, extends eastward on the line about 1,100 feet, then inclines towards the shore in a depth of 25 feet of water, and extends 2,400 feet, having an entrance 1,200 feet wide between the eastern end and the curve of 14 feet depth of water, or about 2,200 feet from shore.

The latest project enlarges the east breakwater by extending the lake arm 3,500 feet to the east before change of direction is made, and then the shore-arm is continued 2,000 feet as before, but ends in a depth

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of 26 feet of water, having an entrance 2,300 feet wide between it and the curve of 14 feet depth of water. For full report of this change of plan see House Ex. Doc. No. 189, Fiftieth Congress, first session.

For the expenditure of the appropriation of August 5, 1886, contracts were made for the construction of about 1,200 linear feet of the east breakwater. Operations were commenced in October, 1886, and were continued, when weather permitted, until end of this fiscal year. By that date the 1,200 feet of east breakwater was about nine-tenths finished, and will be completed to the extent of available funds by July 30, 1888.

The amount expended during the fiscal year was $151,824.07.

At the close of the fiscal year ending June 30, 1888, a total of about $942,014.25 had been expended and 7,960 linear feet of breakwater had been finished, which completes the west breakwater, and over 800 linear feet of the east breakwater, leaving to be built to complete the harbor of refuge about 4,700 linear feet of east breakwater.

The total amount appropriated for the harbor of refuge to July 1, 1888, is $993,750, of which sum $977,514.25, exclusive of outstanding liabilities, has been expended, less about $35,500 applied to repairs to piers, dredging, etc., for Cleveland Harbor proper.

July 1, 1887, amount available		$165,922.98
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$149,687.23	
July 1, 1888, outstanding liabilities	10,518.26	
July 1, 1888, amount covered by existing contracts	5,717.49	
		165,922.98
Amount appropriated by act of August 11, 1888		100,000.00
Amount (estimated) required for completion of existing project		519,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix K K 10.)

11. *Fairport Harbor, Ohio.*—The present project for the improvement of this harbor consists of parallel piers, 200 feet apart, running into the lake. It was adopted in 1825, and has been modified by prolonging the piers from time to time so as to give increased depth, the object now being to afford a channel of navigable width and not less than 16 feet in depth.

When the work of improvement was commenced in 1826 the mouth of the river was closed by a sand-bar 1,200 feet wide, at times so hard and dry that teams could be driven across.

At the close of the fiscal year ending June 30, 1887, there was a good channel between the piers with a least depth of 16 feet at low water, and in the lake beyond end of piers a least depth of 15½ feet at ordinary level of the lake.

Contracts were made and work completed for necessary repairs to piers and for the extension of the east pier 200 linear feet.

During the fiscal year ending June 30, 1888, an agreement was also made in the spring of 1888 for a small amount of dredging in the channel, and by June 6, 1888, it was restored to its required depth, but not to full depth.

Extensive improvements as to docks and yards for receiving cargoes of iron ore and shipping coal have been made at Fairport Harbor by Pittsburgh capitalists. These improvements were continued during the fall of 1887, and it is expected that they will be further extended and the business of this harbor thereby still further increased.

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July 1, 1887, amount available	$15,040.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	15,040.41
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	21,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	21,300.00

(See Appendix K K 11.)

12. *Astabula Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1826. Rock bottom was then found at 9 feet below the surface, and there was a depth of only 2 feet of water on the bar at the entrance.

The present project contemplates the extension of the piers out to 16 feet depth of water, the removal of the decayed portions of both piers and rebuilding with new material, at the same time straightening the line of the west pier so as to afford a uniform width of 160 feet in channel.

At the close of the year 1886 there was a good wide channel, 15½ to 16 feet deep, from the lake into the harbor.

During the year ending December 31, 1887, the previous condition of the channel was restored by the removal of 2,954 cubic yards of soft material by contract.

As the excavation of the rock from the bar in lake and from the channel between the piers was the next step in the approved project, a contract was made for this excavation to the extent of available funds, and the work required under the contract was completed by end of September, 1887. The channel through the outer bar was excavated to 18 feet depth and full width. The channel between the piers was excavated to 17 feet depth and of such width as the available funds permitted, viz, 50 feet, all in rock bottom.

There has been appropriated for this harbor up to the close of the fiscal year ending June 30, 1888, a total of $402,401.21, all of which has been expended.

July 1, 1887, amount available	$19,057.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,057.58
Amount appropriated by act of August 11, 1888	25,000.00
Amount (estimated) required for completion of existing project	25,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	25,300.00

(See Appendix K K 12.)

13. *Conneaut Harbor, Ohio.*—The original project for the improvement of this harbor was adopted in 1829. The design was to afford a depth of 12 feet of water through the bar at the mouth of Conneaut Creek, which bar was dry at low water when work was commenced.

The improvements have been prosecuted at this harbor with more or less interruption and suspension. The best channel ever obtained was 11 feet, and the more usual depth has been 8 or 9 feet. At present the mouth of harbor is closed by a sand-bar, dry at low water. The piers are entirely destroyed, with breaches, through which the stream finds an exit to the east.

Up to the close of the present fiscal year the sum of $112,629.39 has been appropriated for this harbor, all of which sum has been expended.

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The present project for this improvement contemplates rebuilding the east pier and renewing the superstructure of the west pier, at an estimated cost of $35,000.

The last appropriation for this harbor was that of June 14, 1880.

Amount (estimated) required for completion of existing project $35,090.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix K K 13.)

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND DUNKIRK, BUFFALO, WILSON, OLCOTT, OAK ORCHARD, AND TONAWANDA HARBORS, AND NIAGARA RIVER, NEW YORK.

Officer in charge, Captain Frederick A. Mahan, Corps of Engineers.

1. *Erie Harbor, Pennsylvania.*—The original survey of this harbor was made in 1819, at which time the channel was narrow and tortuous, with a depth of only 6 feet. In 1823 a plan for the improvement was adopted, and constitutes the present work at the entrance to the harbor, excepting some changes which have been required either on account of the age of the structures already built or other causes.

The piers have been extended from time to time and are now in good condition.

The present project contemplated the extension of the piers to the 16-foot curve in the lake, and the maintenance of a channel of navigable width and 16 feet in depth from the harbor inside to the lake outside.

Operations have been prosecuted with more or less interruption and suspension (no work was done from 1838 to 1842, from 1846 to 1853, and from 1855 to 1864), and have resulted in much benefit to the harbor and its channel entrance. The work during the fiscal year consisted of the repairs to the piers and breakwaters, and of a survey of the peninsula to determine changes in the shore-line and the direction of the currents along the outside of the peninsula. The channel is now available to its full width for vessels drawing 16 feet of water.

To carry out the recommendations of the Board of Engineer Officers of June 14, 1882, $10,000 of the amount available for the harbor are set aside to provide for the prompt construction of a dike at the neck of the peninsula in case of necessity.

The total amount appropriated for this harbor to June 30, 1888, is $768,867.23, of which $695,983.01 have been expended, including outstanding liabilities.

July 1, 1887, amount available		$80,351.78
Amount deposited to balance account		.04
		80,351.82
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,937.28	
July 1, 1888, outstanding liabilities	530.32	
		7,467.60
July 1, 1888, balance available		72,884.22
Amount appropriated by act of August 11, 1888		23,000.00
Amount available for fiscal year ending June 30, 1889		95,884.22

Amount (estimated) required for completion of existing project..... 24,000.00
Amount that can be profitably expended in fiscal year ending June 30,1890 24,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L L 1.)

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2. *Preservation and protection of the Peninsula of Presque Isle, Erie Harbor, Pennsylvania.*—This is a new work. In a report upon the examination of Erie Harbor made in 1885 it was recommended that the neck of the peninsula be protected by a breakwater, and that the movement of sand around the eastern end of the peninsula, which threatens to close the harbor entrance, be arrested by the construction of jetties perpendicular to the shore of the peninsula, at an estimated cost of $173,044.50.

The river and harbor act of August 11, 1888, appropriates $60,000 for the work, and a further sum of $60,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$60,000.00
Amount (estimated) required for completion of existing project	113,044.50
Amount that can be profitably expended in fiscal year ending June 30, 1890	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

3. *Dunkirk Harbor, New York.*—A project for the improvement of this harbor was adopted in 1870, the object being to form an artificial harbor by constructing a breakwater 2,860 feet long and nearly parallel with the shore, and by excavating a channel so as to afford a depth of 13 feet into this harbor.

The breakwater construction has been carried out in part, 1,341 feet having been completed at a cost of $98,000. The excavated channel is quite narrow, and presents ragged edges of unblasted rock jutting out from either side. As it is exposed to winds and waves from any direction from northwest to northeast, it is somewhat dangerous at times for vessels trying to come in.

During the fall and winter of 1886–'87 the west breakwater was badly damaged, a breach 300 feet long having been made in it. The superstructure was carried away, as well as much of the foundation cribs. The east breakwater was also much injured.

Work during the fiscal year consisted in trying to close the breach in the west breakwater. Nine cribs were put down. Of these six were entirely carried away by the gales of October 3 and 4 and October 23 and 24, 1887. Three of the cribs remained, and on them the superstructure was laid and completed. A few minor but urgent repairs were made to the east breakwater.

This last-named work is in such bad condition that any attempt at small repairs is a waste of money. It needs to be entirely rebuilt. This should be done so soon as possible.

Up to June 30, 1888, there had been appropriated for this harbor a total sum of $479.079.38, of which $477,489.16 have been spent.

July 1, 1887, amount available	$8,299.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,709.01
July 1, 1888, balance available	1,590.22
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,590.22
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 2.)

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4. *Buffalo Harbor, New York.*—The original project for the improvement of this harbor was adopted in 1826, the date of the first appropriation, and, as modified at various times, provided for the construction of piers on the north and south sides of Buffalo Creek, a masonry sea-wall running south from the inshore end of the south pier, and a breakwater less than half a mile in front of the Buffalo light-house, its long arm being nearly parallel with the shore.

The present project was adopted in 1874, and provides for the construction of a breakwater of crib-work 7,600 feet long, running parallel with the shore, and a shore-arm of piles and crib-work 4,100 feet long, running out toward the southern end of the main or detached breakwater, leaving an opening of about 150 feet between them.

A length of 1,460 feet north of the north timber parapet of the breakwater is in a very dilapidated condition and should be rebuilt at once. It was badly wrecked by a severe gale on October 14, 1886. Another section about 1,500 feet long, south of the north timber parapet, is becoming very rotten and can not hold together much longer. It should be replaced with masonry.

During the past year a length of 250 feet of the superstructure, beginning from the north end of the breakwater, was rebuilt with natural-cement concrete faced with Portland-cement concrete, and an additional length of 200 feet was partly rebuilt with concrete faced with stone. Both new parts have stood well. The ice during the winter was exceptionally heavy, but no damage was done to the new superstructure.

Very extensive minor repairs were made to the timber portion of the work, which was badly damaged by the ice of the winter of 1886–'87, by the gales of October 3 and 4 and 23 and 24, 1887.

Slight repairs were made to the south pier.

The works are all in good condition except the breakwater, much of which is in as bad shape as it well can be.

The total amount appropriated and allotted for this harbor up to June 30, 1888, was $1,966,480.41, of which the sum of $1,959,920.73, inclusive of outstanding liabilities, has been expended, resulting in the construction of the north and south piers, the sea-wall, 870 linear feet of pile-pier, and 6,355 feet of main breakwater.

July 1, 1887, amount available		$86,960.76
Amount refunded by contractors on account of overpayment		325.28
		87,286.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$79,230.47	
July 1, 1888, outstanding liabilities	1,495.89	
		80,726.36
July 1, 1888, balance available		6,559.68
Amount appropriated by act of August 11, 1888		225,000.00
Amount available for fiscal year ending June 30, 1889		231,559.68
Amount (estimated) required for completion of existing project		892,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		400,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix L L 3.)

5. *Tonawanda Harbor and Niagara River, New York, etc.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of the harbor and river referred to, and the report thereon was trans-

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mitted to Congress January 13, 1888, and printed as House Ex. Doc. No. 83, Fiftieth Congress, first session.

The improvement proposed is the construction of a channel for vessels drawing 16 feet between the points above indicated, involving channels at Horse Shoe Reef, at head of Strawberry Island, and river front at Tonawanda, etc., at a total estimated cost of $593,538.

The river and harbor act of August 11, 1888, appropriates $100,000 for the work, and a further sum of $100,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$100,000.00
Amount (estimated) required for completion of existing project	493,538.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

6. *Wilson Harbor, New York.*—The project for the improvement of this harbor was adopted in 1873 and modified in 1877, the object being to afford a channel of navigable width and 12 feet in depth by the extension of parallel piers from the mouth of Twelve-Mile Creek to the 12-foot curve in Lake Ontario, with the formation of a protected channel between the piers. The mouth of the creek was originally obstructed by a bar upon which there was a depth of about 1 foot.

Before the commencement of operations by the United States the piers had been carried about 400 feet into the lake by private enterprise.

During the past year the piers were thoroughly repaired. They are now in good order.

The amount appropriated to June 30, 1888, is $60,000, of which $56,799.46, including outstanding liabilities, have been expended, with the result of extending the piers to the 8-foot curve in the lake.

July 1, 1887, amount available		$8,283.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$702.19	
July 1, 1888, outstanding liabilities	481.10	
July 1, 1888, amount covered by existing contracts	3,900.00	
		5,083.29
July 1, 1888, balance available		3,200.54
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		8,200.54

Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 5.)

7. *Olcott Harbor, New York.*—The project for the improvement of this harbor was adopted in 1866. It proposes to connect the deep water in Lake Ontario with the deep water in Eighteen-Mile Creek by the extension of two parallel piers from the mouth of the creek to the 11-foot curve in the lake, with the addition of a dredged channel between the piers. The project was modified in 1874 and in 1881 to provide for the removal of rock found to exist in the channel between the piers and for additional pier extension. The natural channel between the mouth of the creek and the lake was obstructed by a bar upon which there was a depth of about 1½ feet.

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During the past year 368 feet of the west pier and 371 feet of the east pier were rebuilt from below the water-line up. Minor repairs were also made. They are both in good condition.

Up to June 30, 1888, the sum of $128,000 had been appropriated for this harbor, of which $125,207.66 had been spent in the extension of the piers to the 9-foot curve in the lake and the formation between the piers of a channel of navigable width and about 7½ feet deep at low water.

July 1, 1887, amount available	$5,086.30
Amount refunded by contractor on account of extra cost of timber purchased in open market	303.28
	5,389.58
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,597.24
July 1, 1888, balance available	2,792.34
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	7,792.34
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 6.)

8. *Oak Orchard Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1836, the date of the first appropriation, and proposed the construction of an east and west breakwater approaching to within 200 feet of each other, and connecting at the opening with two parallel piers extending into the lake.

Subsequent modifications were extensions of the original project to provide for the removal of rock, and to adjust the harbor to the increased demand of commerce. The present project was adopted in 1881, the object being to extend the piers to the 12-foot curve in the lake with the formation of a channel of navigable width and 12 feet deep at low water between the piers. The natural entrance into Oak Orchard Creek was narrow, with a depth of from 2 to 4 feet.

During the past year the whole of the east pier was rebuilt from below the water-line. Both piers are in good condition.

The total amount appropriated for the harbor up to June 30, 1888, is $194,000, of which there has been spent $192,632.40, resulting in extending the piers to the 12-foot curve in the lake and securing a channel of navigable width and 12 feet deep at low water.

July 1, 1887, amount available	$3,213.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,845.63
July 1, 1888, balance available	1,367.60
Amount appropriated by act of August 11, 1888	6,000.00
Amount available for fiscal year ending June 30, 1889	7,367.60
Amount (estimated) required for completion of existing project	86,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix L L 7.)

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EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Captain Mahan was charged with and completed the survey of *Tonawanda Harbor and Niagara River, New York, between Black Rock and Tonawanda, with a view to a 16-foot channel*, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 83, Fiftieth Congress, first session. (See also Appendix L L 8.)

IMPROVEMENT OF HARBORS ON LAKE ONTARIO EAST OF OAK ORCHARD, NEW YORK.

Officer in charge, Capt. Carl F. Palfrey, Corps of Engineers.

1. *Charlotte Harbor, New York.*—The original project for the improvement of this harbor, adopted in 1829, proposed to connect the deep waters in the Genesee River with the deep water in the lake by parallel piers about 480 feet apart.

The present project, adopted in 1881, is for the extension of the piers to the 15-foot curve in the lake, with the formation by dredging of a channel between them of a navigable width and 15 feet in depth at low water.

The natural channel over the bar was tortuous, and in calm weather would admit, at ordinary stage of the lake, vessels drawing 8 feet.

The total amount expended from 1828 to June 30, 1888, is $394,303.25. The amount expended from the adoption of the present project in 1881 to June 30, 1888, is $76,224.85.

The total expenditure has resulted in extending the piers to the 13-foot curve in the lake, securing a channel between the piers of navigable width, and of not less than 12 feet in depth at low water.

During the year 1,400 feet of superstructure have been rebuilt and 153 sunken piles removed.

July 1, 1887, amount available		$20,739.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$15,084.53	
July 1, 1888, outstanding liabilities	901.70	
		15,986.23
July 1, 1888, balance available		4,753.15
Amount appropriated by act of August 11, 1888		45,000.00
Amount available for fiscal year ending June 30, 1889		49,753.15
Amount (estimated) required for completion of existing project		28,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		28,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

See Appendix M M 1.)

2. *Great Sodus Harbor, New York.*—The earliest project for the improvement of this harbor, adopted in 1828, proposed the construction of two breakwaters from the east and west shores, approaching to within 500 feet of each other, and connecting at this opening with parallel piers extending into the lake. Subsequent modifications were extensions of the original project, to adjust it to the increased demands of commerce.

The present project was adopted in 1882, the object being to extend

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the piers to the 15-foot curve in the lake and dredging a channel between the piers 15 feet deep at low water.

The natural channel would admit vessels drawing 8 feet at ordinary lake stage.

The total amount expended from 1829 to June 30, 1888, is $408,567.25, including outstanding liabilities. The amount expended from the adoption of the present project in 1881 to June 30, 1888, is $51,027.13. The total expenditure has resulted in the extension of the west pier to the 14-foot curve in the lake, and of the east to the 9-foot, with a channel of navigable width and 10 feet deep at low water between them.

The operations of the past fiscal year have been renewal of superstructure on 926 feet of east breakwater, sheet-piling along 250 feet of west pier, and a temporary improvement of the channel by pump-dredging.

July 1, 1887, amount available		$14,262.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$9,181.85	
July 1, 1888, outstanding liabilities	.60	
		9,182.45
July 1, 1888, balance available		5,079.88
Amount appropriated by act of August 11, 1888		24,000.00
Amount available for fiscal year ending June 30, 1889		29,079.88
Amount (estimated) required for completion of existing project		24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		24,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix M M 3.)

3. *Little Sodus Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1829, and has since been variously modified. The first appropriation was made in 1852. The early project proposed the partial closing of the opening between the bay and the lake by lateral dikes connected with two parallel piers extending into the lake.

The present project, which is an expansion of the earlier ones, was adopted in 1881, and is designed to afford a channel of navigable width of not less than 15 feet depth at low water.

The total amount expended from the date of the first appropriation in 1852 to June 30, 1888, is $274,964.24, including outstanding liabilities. The amount expended from the adoption of the present project in 1881 to June 30, 1888, is $40,522.47. The total expenditure has resulted in the extension of the piers to the 12-foot curve in the lake, securing a channel between the piers of navigable width and 12 feet in depth at extreme low water.

The operations of the past fiscal year have been the building of 200 feet of fascine and stake revetment in front of west breakwater, renewal of superstructure on 512 feet of east pier, and minor repairs.

July 1, 1887, amount available		$14,193.08
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		7,165.55
July 1, 1888, balance available		7,027.53
Amount appropriated by act of August 11, 1888		16,000.00
Amount available for fiscal year ending June 30, 1889		23,027.53

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Amount (estimated) required for completion of existing project	$17,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 4.)

4. *Oswego Harbor, New York.*—The earliest project for the improvement of this harbor was adopted in 1827, and proposed to inclose an area at the mouth of the river by extending jetties from the shore into the lake, joining the outer ends by a breakwater, but leaving an opening through which to enter the harbor.

The project was completed in 1869, and forms the present inner harbor.

The present project was adopted in 1870, and consists of a breakwater 5,800 feet in length, parallel to the old west breakwater, and 1,100 feet in advance of it. The estimated cost was $1,161,682. It was subsequently modified by the proposed construction of an east breakwater, 2,700 feet in length, the reduction of 350 feet of the opening between the east end of the west breakwater and the north end of the light-house pier, the construction of spurs along the face of the outer west breakwater to reduce the effect of accumulated seas, and for deepening by dredging the inner harbor at the mouth of the Oswego River.

The object of these improvements was to give protection to the city docks and wharves, and to the commerce of the harbor and lake a depth suitable for the heaviest draught vessels on the lakes.

The natural entrance to the mouth of the river was shallow and difficult of access.

The total amount expended from the date of the first appropriation in 1826 to June 30, 1888, is $1,607,854.63, including outstanding liabilities. The amount expended from the adoption of the present project in 1870 to June 30, 1888, is $1,134,521.90.

The total expenditure has resulted in the completion of the originally projected harbor, the completion of the west breakwater, with the reduction of 350 feet of the opening between the east end of west breakwater and the north end of the light-house pier, the construction of 213 linear feet of the east breakwater, the completion of one spur-crib, and the deepening of the river mouth to a depth of 15 feet at low water, securing full protection to the docks and wharves west of the river mouth, and channels of entrance 16 feet deep and 350 feet wide each to the inner and outer harbors and 15 feet deep at low water.

Early in December, 1884, a severe northwest storm caused a breach in the west breakwater 145 feet in width, and necessitating repairs for a length of 100 feet each side of the breach. This portion of the breakwater has been repeatedly breached. To remove and rebuild the old work the officer in charge estimates would cost $80,000.

The operations of the past fiscal year have been renewal of superstructure on 846.3 feet of outer west breakwater and minor repairs.

July 1, 1887, amount available	For repairs	$47,737.78	
	Continuing improvement	15,000.00	
			$62,737.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		34,110.72	
July 1, 1888, outstanding liabilities		989.02	
			35,099.74
July 1, 1888, balance available			27,638.04
Amount appropriated by act of August 11, 1888			100,000.00
Amount available for fiscal year ending June 30, 1889			127,638.04

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Amount (estimated) required for completion of existing project	$60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 5.)

5. *Sackett's Harbor, New York.*—The project for the improvement of this harbor was adopted in 1881, and proposed the deepening of the harbor over an area of about 15 acres to a depth of 12 feet at low water. The depth previously existing was less than 8 feet over a large part of its area.

In 1826 and 1828 the sum of $6,000 was expended in clearing and deepening the harbor.

The total amount expended from 1826 to June 30, 1888, is $12,752.15. The amount expended from the adoption of the present project to June 30, 1888, is $6,752.15, and has resulted in the removal of 24,010 cubic yards of sand, mud, and gravel. With the completion of that work the harbor had a depth of 12 feet at low water over about 6 acres of its area, except in a small part where the presence of rock in place limited the depth to a little less than 12 feet.

No work done during the year.

July 1, 1887, amount available	$72.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11.97
July 1, 1888, balance available	60.14
Amount appropriated by act of August, 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,060.14

Amount (estimated) required for completion of existing project	13,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix M M 6.)

IMPROVEMENT OF OGDENSBURGH HARBOR ON THE RIVER SAINT LAWRENCE, OF HARBORS ON LAKE CHAMPLAIN, AND OF GRASS AND TICONDEROGA RIVERS, NEW YORK, AND OF OTTER CREEK, VERMONT.

Officer in charge, Maj. Milton B. Adams, Corps of Engineers.

1. *Ogdensburgh Harbor, New York.*—The present project for the improvement of this harbor, which was adopted in 1882, contemplates the deepening of the channels along the city front and the prolongation of the lower reach of the Oswegatchie to deep water in the St. Lawrence River, so as to afford a depth of 15 feet in the channels, and 16 feet on the outer bar at extreme low water.

When operations were commenced at this harbor the channels afforded depths of 5 to 12 feet only, and now there are two good channels from deep water in the St. Lawrence to the nearest docks or wharves, in which water from 15 to 16 feet deep is afforded, and a channel 12 feet deep and 150 feet wide has been made along the city front and is undergoing deepening to 15 feet.

At the close of operations, August 31, 1887, the channel along the city front had been made 15 feet deep and 100 feet wide from its lower end to a point opposite Hannan's Dock, a total length of 2,900 feet, and all available funds were consumed. The total amount expended from the date of the first appropriation in 1852 to June 30, 1888, has been $146,680.87, and from the adoption of the present project, $36,680.87.

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July 1, 1887, amount available	$6,568.44
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,568.44
Amount appropriated by act of August 11, 1888	15,000.00
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 1.)

2. *Grass River (at Massena), New York.*—The project for the improvement of this river was adopted in 1881, and has for its object the formation of a channel with a least depth of 4 feet and a least width of 40 feet from the St. Lawrence River to the village of Massena, a distance of about 7½ miles by water.

The natural depth of the shoal places is about 2 feet. The act of August 2, 1882, appropriated $3,000 for this work.

July 1, 1887, amount available	$2,948.60
July 1, 1888, balance available	2,948.60
Amount (estimated) required for completion of existing project	17,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 2.)

3. *Breakwater at Rouse's Point, Lake Champlain, New York.*—The project for this improvement was adopted in 1885, and contemplates the construction of a breakwater composed of rubble and large stone on a straight line extending from Stony Point until the 18 foot curve in the lake is reached, a total distance of about 2,000 feet.

The estimated cost of the breakwater is $110,000. Work was commenced by contract September 1, 1885, and has been in progress since that time. The first contract is completed and comprises the section, 800 feet long, extending from the shore to the 12-foot curve. The second contract, comprising the extension of the shore section to the 14-foot curve, 550 feet, is in progress and when completed, November 30, 1888, will exhaust the available funds.

There have been $47,686.73 expended on this work to June 30, 1888, including outstanding liabilities.

The good effects of the completed improvement are already apparent in the increased shelter afforded at the docks and wharves by the portion of the breakwater which has been finished.

July 1, 1887, amount available		$23,970.59
July 1, 1888, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1887	$14,402.21	
July 1, 1888, outstanding liabilities	2,255.11	
July 1, 1888, amount covered by existing contracts	6,985.00	
		23,642.32
July 1, 1888, balance available		328.27
Amount appropriated by act of August 11, 1888		13,500.00
Amount available for fiscal year ending June 30, 1889		13,828.27
Amount (estimated) required for completion of existing project		41,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix N N 3.)

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4. *Swanton Harbor, Vermont.*—The project for the improvement of this harbor was adopted in 1873, and had for its object the protection of anticipated docks and wharves by the construction of a breakwater in front of the place most likely to be selected as their location.

The amount expended to June 30, 1888, is $70,188.07 and has resulted in the construction of the existing breakwater.

Its site was necessarily selected before the docks since built by private parties were located, and these shipping facilities of the harbor have been, unfortunately, so placed that very little, if any, benefit in the way of protection is derived from the breakwater.

July 1, 1887, amount available	$326.93
July 1, 1888, balance available	326.93
Amount (estimated) required for completion of existing project	169,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 4.)

5. *Channel between the islands of North Hero and South Hero, Lake Champlain, Vermont.*—This is a new work. In compliance with a resolution of the Senate of the United States, dated January 15, 1887, a report of an examination of the above channel was submitted and printed as Senate Ex. Doc. 38, Forty-ninth Congress, second session. (Appendix O O 11 of the Report of the Chief of Engineers for 1887.)

The proposed improvement provides for the removal of about 12,000 cubic yards (mostly bowlders) at the west end of "The Gut" channel at an estimated cost of $14,300.

The river and harbor act of August 11, 1888, appropriates $10,000 for the work, and a further sum of $4,300 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	4,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	4,300.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

6. *Breakwater at Gordon's Landing, Lake Champlain, Vermont.*—The project for this improvement was adopted in 1887, and has for its object the construction of a stone breakwater, composed of rubble and large stones, extending in a straight line to the 18-foot curve in the lake, for the purpose of increased shelter to a landing on the west shore of Grand Isle, Lake Champlain. There was necessarily some delay attendant on the preparation of the project for this work, as no preliminary examination of the locality had been made prior to the appropriation, consequently the actual work of construction did not commence until August 11, 1887, and has been progressing under contract since then. Nearly all the rubble stone required for the 500 feet shore section has been placed, and it is expected that the contract which comprises the construction of the above section will be completed by the close of this season's operations, practically consuming the available funds.

July 1, 1887, amount available		$18,413.9
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,192.27	
July 1, 1888, outstanding liabilities	400.01	
July 1, 1888, amount covered by existing contracts	11,149.94	
		16,742.22
July 1, 1888, balance available		1,671.68
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,671.68

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Amount (estimated) required for completion of existing project	$9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	9,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 5.)

7. *Plattsburgh Harbor, New York.*—The first appropriation for the improvement of this harbor was in 1836. The project adopted and its modifications have resulted in the construction of 1,250 feet of breakwater, the protection of a portion of the beach and the dredging of shoal areas within the harbor.

Under the appropriation of August 5, 1886, proposals were invited and a contract made for dredging 25,000 cubic yards from the shoal areas within the harbor. This contract was completed and closed in November, 1887, practically consuming the available funds.

The total amount expended at this harbor to June 30, 1888, has been $143,022.58, of which amount $57,522.58 were expended since the adoption of the modified project in 1870.

July 1, 1887, amount available	$4,903.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,426.23
July 1, 1888, balance available	477.42
Amount appropriated by act of August 11, 1888	7,000.00
Amount available for fiscal year ending June 30, 1889	7,477.42

(See Appendix N N 6.)

8. *Burlington Harbor, Vermont.*—This improvement dates from 1836. Modifications of the original plan have been made from time, so as to afford adequate protection to the increasing commercial and shipping interests of the harbor. The last modification, made in 1886, provides for further extension of the breakwater, both to the north and to the south, with its gradual withdrawal, as it is prolonged into water about 30 feet deep instead of 38 feet, to reduce the cost of the work.

Operations during the past year consisted in placing 4,209.2 cubic yards of rubble-stone in the foundation of 240 feet of extension to the southern end of the breakwater.

The contract under which the above foundation is being constructed also comprises the building of six cribs, the sinking of the same, and covering them with a superstructure.

This contract will doubtless be completed by the close of the present season of operations, and will practically consume the available funds.

July 1, 1887, amount available		$20,570.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$4,655.39	
July 1, 1888, outstanding liabilities	1,194.95	
July 1, 1888, amount covered by existing contracts	13,074.46	
		18,924.80
July 1, 1888, balance available		1,645.44
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,645.44

Amount (estimated) required for completion of existing project	149,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 7.)

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9. *Otter Creek, Vermont.*—The project for this improvement proposes the formation of a channel of navigable width and a least depth of 8 feet from Vergennes, Vt., to Lake Champlain.

No operations have been carried on since the improvement of Bull Brook Bend and vicinity, in 1884, when this obstruction was entirely removed, so as to afford a good channel 75 feet wide and 8 feet deep at low water.

There have been expended to June 30, 1888, $33,351.66.

The channels at Steam-boat Landing, Sharkie's and Crittenden's bends, and at the mouth are still to be widened and deepened to complete the project for improvement.

July 1, 1887, amount available	$648.34
July 1, 1888, balance available	648.34
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	3,148.34
Amount (estimated) required for completion of existing project	37,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 8.)

10. *Ticonderoga River, New York.*—The project for this improvement was adopted in 1881, its object being to afford a channel of navigable width and a least depth of 8 feet at low water from Ticonderoga Village to Lake Champlain, a distance of about 2 miles.

The original estimated cost of the improvement was $42,516, of which amount $12,000 have been appropriated, and as expended have resulted in an improved channel.

The channel requires very general widening and deepening in order to carry out the project of improvement.

July 1, 1887, amount available	$1,864.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,805.89
July 1, 1888, balance available	58.71
Amount appropriated by act of August 11, 1888	2,500.00
Amount available for fiscal year ending June 30, 1889	2,558.71
Amount (estimated) required for completion of existing project	28,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix N N 9.)

11. *Narrows at Lake Champlain, New York and Vermont.*—The project for this improvement was adopted in 1885, and has for its object the removal of such obstructions in the channel as will afford a least depth of 12 feet and a least width of 150 feet, at low water, from Whitehall Harbor, New York, to Benson's Landing, Vt. The entire undertaking was estimated to cost $86,000, of which amount $30,000 have been appropriated. Contracts were made for the removal of the rock-reef at Elbow, near Whitehall, N. Y., and the dredging of Kenyon's Bay, near Benson's Landing, Vt., and both were well under way at the close of last fiscal year.

The former contract was completed and closed in July, 1887, the other is to be completed July 30, 1888, which will about consume the available funds.

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July 1, 1887, amount available		$26,858.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$16,333.35	
July 1, 1888, outstanding liabilities	6,264.97	
July 1, 1888, amount covered by existing contracts	2,502.07	
		25,100.39
July 1, 1888, balance available		1,758.55
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		16,758.55
Amount (estimated) required for completion of existing project		41,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		41,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix N N 10.)

PACIFIC COAST.

IMPROVEMENT OF NAPA RIVER AND OF THE HARBORS OF OAKLAND AND REDWOOD, CALIFORNIA.

Officer in charge, Col. G. H. Mendell, Corps of Engineers.

1. *Napa River, California.*—This is a new work. In compliance with the requirements of the river and harbor act of July 5, 1884, a preliminary examination and survey were made of Napa River from the mouth to Napa City, Cal., and the report thereon is printed in the Report of the Chief of Engineers for 1885, Part 3, as Appendix P P 8.

The improvement proposed was the making of a channel 4 feet deep, 75 feet wide from the mouth of the river to the bridge at the city and 50 feet above it, at an estimated cost of $27,600.

The river and harbor act of August 11, 1888, appropriates $7,500 for the work, and a further sum of $10,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act of August 11, 1888	$7,500.00
Amount (estimated) required for completion of existing project	20,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2. *Oakland Harbor, California.*—The natural low-water depth at the entrance of this harbor was about 2 feet. The present depth is 9.5 feet. The project provides for a ship-channel of 18 to 20 feet.

The general features of the project are:

(1) Two high-tide stone jetties extended into San Francisco Bay to a depth of about 13 feet.

(2) A tidal canal, 400 feet in width, 8 feet in depth, admitting to the head of the harbor tidal water from San Leandro Bay.

(3) A dam at mouth of San Leandro Bay.

(4) Increase of tidal prism by dredging a basin; and

(5) Dredging interior channels.

No operations, except those of supervision, were carried on during the past year.

The dredged channels show a slight diminution of maximum depth 1 foot or less during the year, accompanied generally with a considerable increase of area of channel section, as compared with the condition at the close of the last dredging in 1882.

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The jetties have undergone no noticeable change during the past year.

The amount appropriated to June 30, 1888, is		$934,600.00
The amount expended, including liabilities, is		928,856.05
July 1, 1887, amount available		8,278.28
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,174.33	
July 1, 1888, outstanding liabilities	60.00	
		2,234.33
July 1, 1888, balance available		6,043.95
Amount appropriated by act of August 11, 1888		350,000.00
Amount available for fiscal year ending June 30, 1889		356,043.95
Amount (estimated) required for completion of existing project		1,241,000.00
Amount that can be profitably expended in fiscal year ending June 30 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix O O 1.)

3. *Redwood Harbor, California.*—The project is to dredge the portion of Redwood Creek adjacent to Redwood City for a distance of 6,000 feet, to accommodate the vessels trading at that port. These vessels have a capacity of 50 to 60 tons.

The Government dredge was engaged in making this channel at the beginning of the fiscal year. It had then gone over about 2,900 feet in length. In July and to August 3, when it was withdrawn to work elsewhere, it dredged 870 feet more, leaving about 2,300 feet untouched.

July 1, 1887, amount available	$3,455.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,794.92
July 1, 1888, balance available	1,660.84
Amount appropriated by act of August 11, 1888	7,400.00
Amount available for fiscal year ending June 30, 1889	9,060.84

(See Appendix O O 2.)

4. *Survey of San Francisco Harbor, San Pablo and Suisun bays, Straits of Carquinez, and mouths of Sacramento and San Joaquin rivers, California.*—A party took the field on August 17, 1887, and continued a hydrographic survey of San Francisco Harbor until January 31, 1888, when the party was withdrawn on account of bad weather. During this interval 110.5 square miles were covered by survey, extending in latitude from a parallel 1½ miles south of Point Avisadero to a point one-half mile north of Red Rock, and in longitude from the Alameda shore to Raccoon Straits, covering most of the city fronts of San Francisco and Oakland.

Special examination of shoals, with samples procured by borings, was included.

The maps embodying this information are all completed except one, which is well advanced.

This survey covers rather more than half of the area that may be rated as San Francisco Harbor, leaving the western half, including the entrance, as yet unsurveyed.

The estimate herewith is intended to extend the survey over the entrance.

The total amount appropriated is $11,000.

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The amount expended, including liabilities, is $8,985.15.

July 1, 1887, amount available		$11,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,678.48	
July 1, 1888, outstanding liabilities	306.67	
		8,985.15
July 1, 1888, balance available		2,014.85

Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	14,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix O O 3.)

IMPROVEMENT OF THE HARBORS AT SAN LUIS OBISPO, WILMINGTON, AND SAN DIEGO, CALIFORNIA.

Officer in charge, Maj. W. H. H. Benyaurd, Corps of Engineers. Supervising Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Harbor at San Luis Obispo, California, etc.*—This is a new work. In compliance with the requirements of the river and harbor act approved August 5, 1886, an examination was made of the harbor of San Luis Obispo, California, with the view of establishing a breakwater at or near Whaler's Point, and the report thereon is printed as Appendix R R 3 of the Report of the Chief of Engineers for 1887.

The estimated cost of the proposed breakwater is $284,898.

The river and harbor act of August 11, 1888, appropriates $25,000 for the work, and a further sum of $50,000 may be profitably expended in continuing it during the fiscal year ending June 30, 1890.

Amount appropriated by act passed August 11, 1888	$25,000.00

Amount (estimated) required for completion of existing project	259,898.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2. *Wilmington Harbor, California.*—The present project is intended to secure a depth from 14 to 16 feet at mean low tide. When the improvement was begun in 1871, there was a depth of about 1 foot at the entrance; the operations, however, have resulted in securing a greatly increased depth and width of channel. A recent survey of the harbor shows that a depth of 12 feet at mean low tide exists throughout the length of the inner and outer channels. It is intended to gain the additional increased depth required by dredging and by raising and extending the jetties. These operations will be carried on during the coming season and in the future under the existing project, to the extent of the funds made available for the improvement.

The total amount appropriated for this harbor is $780,000, and the amount expended is $735,126.60.

July 1, 1887, amount available		$71,714.06
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$26,833.39	
July 1, 1888, outstanding liabilities	7.27	
		26,840.66
July 1, 1888, balance available		44,873.40
Amount appropriated by act of August 11, 1888		90,000.00
Amount available for fiscal year ending June 30, 1889		134,873.40

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Amount (estimated) required for completion of existing project	$85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	85,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix P P 1.)

3. *San Diego Harbor, California.*—The project for this improvement was made in 1875, and the work was completed in 1876, the object being to prevent the filling up of the harbor by material brought down by the San Diego River during flood stages. The work consisted in cutting a new water-way, so as to cause the river to empty into False Bay, and in building a levee across the old channel near its entrance into the harbor.

The amount appropriated since 1875 is $81,000, and the amount expended $80,958.09.

The general condition of the work is good, but it is in need of certain repairs.

July 1, 1887, amount available	$111.19
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	69.28
July 1, 1888, balance available	41.91
Amount appropriated by act of August 11, 1888	1,000.00
Amount available for fiscal year ending June 30, 1889	1,041.91

(See Appendix P P 2.)

4. *Surveys of San Diego Harbor, Newport Harbor, and San Luis Obispo Harbor, California.*—These surveys were made in accordance with a proviso in section 1 of the river and harbor act of August 5, 1886, and reports thereon submitted to Congress and printed as follows:

Survey of San Diego Harbor in House Ex. Doc. No. 177, Fiftieth Congress, first session.—(See also Appendix P P 3.)

Survey of Newport Harbor in House Ex. Doc. No. 215, Fiftieth Congress, first session.—(See also Appendix P P 4.)

The report on survey of *San Luis Obispo Harbor* is printed in Senate Ex. Doc. No. 81, Forty-ninth Congress, second session; also in Appendix R R of the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1887.

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT, TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Major Benyaurd, was charged with and completed the survey of *San Pedro Bay, California, near the entrance to Wilmington Harbor, with a view to establishing an outer harbor for the protection of deep draught vessels*, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 191, Fiftieth Congress, first session.—(See also Appendix P P 5.)

IMPROVEMENT OF ENTRANCE TO HUMBOLDT BAY; OF SAN JOAQUIN, MOKELUMNE, SACRAMENTO, AND FEATHER RIVERS, AND PETALUMA CREEK, CALIFORNIA.

Officers in charge, Capt. A. H. Payson, Corps of Engineers, to November 23, 1887, since which date Maj. W. H. Heuer, Corps of Engineers. Supervising Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *San Joaquin River, Stockton and Mormon sloughs, California.*—The project adopted in 1877 and slightly modified in 1881 had for its object to secure and maintain a channel 9 feet deep and 100 feet wide

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to Stockton, 4 feet deep and 80 feet wide to Miller's Warehouse in Mormon Slough to straighten the river by cut-offs below the mouth of Stockton Slough and to temporarily improve the low-water channel of the Upper San Joaquin by the removal of snags, scraping bars, and construction of wing-dams. Before work was commenced the channel to Stockton had at low-water stage a depth of only 6 feet. The upper river was navigable to Hill's Ferry, for boats drawing 2 feet or less, for six or seven months of the year.

Up to June 30 there had been expended on the San Joaquin and sloughs $144,880.44. During the fiscal year just ended there was spent in dredging at Stockton Slough and in the main river at Dutchman's Reach $13,073.92. About 144,975 cubic yards of dredging was done, and the excavated material was forced ashore. In Stockton Slough an excavation was made 50 feet by 9 feet by 7,663 feet in length on the south side of the slough, and one was made on the north side the same depth and width and 2,200 feet long. In Dutchman's Reach a channel was made 150 feet wide, 850 feet long, and having a depth of 9 feet at low tide. Annual dredging in the Stockton Slough and in the main river below the slough will be necessary to maintain navigable channels. Wherever dredging has been done and interrupted for any length of time in the slough, the cut has refilled. Where cut-offs have been made in the river the channel produced has maintained. Two more cut-offs below Stockton Slough would be beneficial to navigation; they are estimated to cost $125,000. On account of lack of funds only seven months of dredging could be done on this improvement. The crevasse at Paradise Cut ought to be partially closed, and was estimated to cost $14,000. A dam may have to be built at Laird's Slough on the upper river to prevent the river from leaving its present bed and to prolong navigation for a few weeks in each year. The estimated cost of the dam is $9,570.

The act of August 11, 1888, making an appropriation for improving this river, provides for closing Laird's Slough and the partial closure of "Paradise Cut." The amount estimated for the completion of the approved project is therefore increased.

July 1, 1887, amount available	$13,869.56
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	13,073.92
July 1, 1888, balance available	795.64
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,795.64
Amount (estimated) required for completion of existing project	124,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix Q Q 1.)

2. *Mokelumne River, California.*—The project for improvement was adopted in 1884, and had for its object the removal of snags and overhanging trees between the mouth of the river and Benson's Ferry.

Up to June 30, 1887, there had been spent on the improvement $10,960.58; both forks of the river were cleaned out to Benson's Ferry, as contemplated. No work was done during the past year, owing to lack of funds.

A little snagging will occasionally be necessary to keep the river in a good navigable condition; hence no estimate for final completion can be made.

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July 1, 1887, amount available	$39.42
July 1, 1888, balance available	39.42
Amount appropriated by act of August 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,039.42

(See Appendix Q Q 2.)

3. *Sacramento and Feather rivers, California.*—The project was adopted in 1874 and had for its object the improvement of the low-water channel by wing-dams, scraping of bars, and the removal of snags and trees.

Up to June 30, 1887, there had been expended $320,799.03, including outstanding liabilities, part of which was used in the construction of a snag-boat, two barges, and a dredge-boat.

During the year ending June 30, 1888, there was expended on the river $8,813.84. On account of lack of funds the snag-boat only worked 29 days, removed 283 snags, built 2 wing-dams, blasted off a projecting point of river at Hemstreet's Bend, and blasted and washed out a bar near Walsh's Cut-off, increasing the depth of water on this bar by 2 feet.

Before improvement the channel of the Upper Sacramento River was obstructed by snags, and navigation was very expensive and hazardous; after improvement the snags were removed, depths were increased, navigation was uninterrupted, freight and insurance rates were reduced, there was a great increase in commerce, and navigation was made perfectly safe.

Since 1875, when work was commenced, Congress has appropriated for this work $445,000, of which, up to the close of the present fiscal year, $329,612.87 have been spent; of the balance, $115,387.13, only $1,193.26 is available for use, as the large appropriation ($250,000) made in 1882 and that of 1884 ($40,000) were rendered non-available in consequence of a clause in the act of 1884 which prohibited the expenditure of these funds except as therein provided, and until the Secretary of War was satisfied that hydraulic mining on the Sacramento River and its tributaries had ceased.

Steam-boatmen are now complaining of troublesome navigation near Walsh's Landing, but with the small amount of money available nothing in the way of assistance can be rendered.

No estimate for final completion of the work can be made. Snags will have to be removed annually or navigation must cease. It is estimated that $40,000 can be advantageously spent in the fiscal year ending June 30, 1890.

July 1, 1887, amount available	$124,200.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,813.84
July 1, 1888, balance available	115,387.13
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	135,387.13
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

(See Appendix Q Q 3.)

4. *Petaluma Creek, California.*—The project adopted in 1880 had for its object to straighten the channel by cut-offs and secure, by dredging for about 8,000 feet below Petaluma, a channel 50 feet wide and 3 feet deep at low water. Before improvement the channel was very crooked and bare at low water. Work was completed in 1884 at a cost of

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$27,656.91, leaving a balance available of $2,343.09. Since then and until within the past two months nothing has been done, and the channel has refilled in places, so that the bottom of the creek in places at low tide is 2 feet out of water. A contract has been made, and dredging is now in progress, to be completed in about one week. About 8,000 cubic yards of material will be excavated, which will relieve the immediate wants of navigation.

July 1, 1887, amount available		$2,343.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$210.24	
July 1, 1888, amount covered by existing contracts	2,132.85	
		2,343.09
Amount appropriated by act of August 11, 1888		2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		2,000.00

(See Appendix Q Q 4.)

5. *Humboldt Harbor and Bay, California.*—The project for the improvement of the bay was adopted in 1881. Its object was to obtain, by dredging, a channel 13 feet deep and 200 feet wide to the upper end of the wharves in Eureka, and to dredge channels 10 feet deep and 100 feet wide to Arcata and Hookton. This work was completed in 1884. It has since deteriorated. In 1882 a project was submitted and adopted to improve the entrance to Humboldt Bay by building a training-wall to the level of low water, extending from the South Spit in a northwesterly direction. The estimated cost of the training-wall was $600,000.

Before improvement began in the bay the channel to Eureka only had a depth of 7 feet; those to Arcata and Hookton had 6-foot depths.

The act of August 5, 1886, provided that no money should be spent in the improvement to entrance of Humboldt Bay until the United States had received, free of expense, a title to the land desired on the South Spit. The deed for the land has just been received.

There has been expended to the end of the present fiscal year $80,884.69.

July 1, 1887, amount available		$136,615.31
July 1, 1888, balance available		136,615.31
Amount appropriated by act of August 11, 1888		125,000.00
Amount available for fiscal year ending June 30, 1889		261,615.31
Amount (estimated) required for completion of existing project		413,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix Q Q 5.)

IMPROVEMENT OF THE ENTRANCES TO COOS AND YAQUINA BAYS, OF MOUTH OF COQUILLE RIVER, OF UMPQUA RIVER, AND OF TILLAMOOK BAY AND BAR, OREGON.

Officers in charge, Capt. Chas. F. Powell, Corps of Engineers, to July 16, 1887, since which date Capt. Willard Young, Corps of Engineers. Supervising Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Coquille River, Oregon.*—At the time the work of improvement was begun the entrance to the Coquille River was considered very dan-

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gerous. It was by a long, tortuous, and narrow channel skirting the south headland, and was studded with rocks from beyond the bar on the outside to a distance of one-half mile inside. The depth at low water over the bar was only about 3 feet, while the position of the bar channel was constantly shifting. The channel sometimes, at long intervals apart, broke through the North Spit and ran directly out to sea, just south of Rackliffe Rock, but did not remain long in this position. The entrance at such times was comparatively safe, and the channel was at its very best. The mean rise of the tide at this place is 4.1 feet.

The plan of the improvement is to open and maintain a channel through the North Spit, and running directly out to sea, just south of Rackliffe Rock, by building a jetty on the south side of the entrance, beginning at a point on the left bank inside the entrance and running across the North Spit at a distance of 800 feet south of Rackliffe Rock, and in a direction nearly west.

The amount expended to June 30, 1888, including outstanding liabilities July 1, 1887, was $49,510.43. One thousand six hundred and twenty-six feet of jetty had been built. The channel through the North Spit was opened in 1882, after the construction of about 1,000 feet of temporary jetty, and soon after the old channel was completely filled up and the jetty across it covered with sand and drift. The new channel when well opened gave a depth of 7 feet at low water over the bar. During 1884 some of the temporary jetty was destroyed by drift, and the adjacent fill was washed out, so that a portion of the outflow escaped uselessly to the south among the rocks, causing a shoaling up of the channel over the bar to a depth of 5 feet. In 1885 the jetty was repaired and extended out to a length of 1,523 feet, giving a channel depth of about 6 feet at low water.

During the year ending June 30, 1888, an extension of 300 feet was made to the jetty pile-work, in which 14,235 linear feet of piling were used; 3,384 cubic yards of stone were quarried and placed in the jetty as filling to the pile-work and as riprap on the channel side. Other operations consisted simply in the storage and care of property and in keeping vessel records.

The jetty thus far constructed is temporary in character and will need to be strengthened throughout most of its length. To obtain a needed 8-foot channel at low water over the bar the present jetty will have to be extended, and probably a jetty on the north side of the entrance will have to be added.

July 1, 1887, amount available		$6,682.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,119.50	
July 1, 1888, outstanding liabilities	73.33	
		6,192.83
July 1, 1888, balance available		489.57
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,489.57
Amount (estimated) required for completion of existing project		94,000.00
Amount that can be profitably expended, including $500 for snagging, in fiscal year ending June 30, 1890		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix R R 1.)

2. *Entrance to Coos Bay, Oregon.*—The obstructions which existed at the entrance to this harbor before the works of improvement were begun consisted first of the outer bar, which is of sand and is shifting in

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character, and, secondly, of the inner shoals formed by the sands which accumulate in the spring, summer, and autumn, during the times when the northwesterly winds prevail. Under the action of these winds the spit on the north side advanced towards the south, contracting the navigable passage under Coos Head to a very narrow width, and usually making the outer channel follow the west side of the spit in a long and tortuous course across the bar. The channel had at times broken through the north spit on a line the general direction of which is from Fossil Point to a point just to the north of Coos Head. It was then direct, the depth of water was greatest, and vessels could enter or go out without trouble. The mean rise of tide above the plane of reference is 5.6 feet.

The project for this improvement, adopted in 1879, is to construct, at an estimated cost of $600,000, a jetty of wood and stone, or of stone, as may be found best, from a point 250 yards below the northern extremity of Fossil Point, on a line towards the east end of Coos Head, this line in plan curving so as to be directed at its outer end to the Head or a little to the north of it. The object is to prevent accretion to the south end of the sand-spit on the north side of the entrance, and to open and maintain a deeper and more direct channel across the outer bar.

The amount expended to June 30, 1888, including outstanding liabilities, was $134,529.10.

July 1, 1887, the jetty had been partly built to a length of 1,761 feet, and had caused a partial erosion of the end of the North Spit, and had opened a channel well to the south, which was deeper, wider, and less exposed to wind and sea than the former channel in its usual position. The new channel was also much less shifting than the old one.

No active operations in jetty building were conducted during the past year. Vessel records were kept, and a watchman was employed to look after the Government property. A supply of water being available for quarry sluicing during the rainy season, the watchman, with a little assistance, succeeded in washing into the bay about 7,000 cubic yards of dirt overlying the ledge at the Fossil Point quarry.

It is expected that the jetty will be extended about 600 feet, and that its top throughout will be raised to 2 feet above low water. The first work to be done, after sufficient funds become available to resume operations, will be to lay a proper foundation course of stone on the line of the proposed extension. This will be needed to prevent the bottom from scouring out, and so to keep the cross-section of the jetty as small as possible.

July 1, 1887, amount available		$30,910.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,433.03	
July 1, 1888, outstanding liabilities	256.49	
		1,689.52
July 1, 1888, balance available		29,220.90
Amount appropriated by act of August 11, 1888		50.000.00
Amount available for fiscal year ending June 30, 1889		79,220.90
Amount (estimated) required for completion of existing project		386,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix R R 2.)

3. *Umpqua River, Oregon.*—Just below Scottsburgh, the head of navigation on the Umpqua River, are five sandstone bars or ledges 12 feet

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to 15 feet wide, and submerged from 1 foot to 2 feet at low tide on a low-river stage. They are separated by pools about 150 feet wide and from 5 to 10 feet deep at low water.

The amount expended on the project to June 30, 1887, including outstanding liabilities, was $4,715.51, and resulted in increasing the controlling depths over the reefs through a channel 50 feet wide, from 1 foot at low water, which formerly existed, to 2 feet at low water.

The total amount appropriated for this work to July 1, 1887, was $4,685.89, and $63.86 has been received from sale of property to other appropriations, making a total of $4,749.75.

No work whatever was done during the past year for want of funds. There has been no change in the channel since June 30, 1887.

It was estimated at the time work was suspended that $2,000 would be required to complete the present project. This amount could be profitably expended in one season.

July 1, 1887, deficiency	$29.62
Received from sale of property to other appropriations	63.86
	34.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	23.49
July 1, 1888, balance available	10.75
Amount appropriated by act of August 11, 1888	2,000.00
Amount available for fiscal year ending June 30, 1889	2,010.75

(See Appendix R R 3.)

4. *Entrance to Yaquina Bay, Oregon.*—The usual prevailing depths over the bar at low water at this entrance before improvement were from 7 feet to 8 feet. Three distinct channels existed, known as the North, Middle, and South channels. The South Channel was the one most used, but was rendered dangerous by the presence of rocks. The Middle Channel, though free from rocks, was usually the shoalest of the three, and so was little used. The North Channel, besides being long and tortuous, was so studded with rocks as to be considered unnavigable. Owing to the shifting nature of the bar these channels were constantly changing, both in position and in depth. The mean rise of the tide is 7.1 feet.

The approved project, adopted in 1881, is to run out a dike or jetty on the south side of the entrance, so as to cause the South Channel to shoal up and the flow to be deflected northward, with a view to opening and maintaining the Central Channel with a least depth of 17 feet at high water.

The amount expended to June 30, 1888, including outstanding liabilities, was $234,353.64. On July 1, 1887, 2,517 feet of jetty and 450 feet of dike for shore protection had been constructed, but not completed to full height and strength. The South Channel had been permanently deflected from the south rocks, and, for a part of the time, made to unite with the Central Channel. The prevailing depths over the bar were greater by 2 or 3 feet, and the channel was less shifting and much safer than formerly. During the past year this jetty has been extended 460 feet.

The present condition of the work makes it apparent that a north jetty, closing the North Channel, must be constructed before the improved channel will be of the necessary depth. An estimate for this jetty was included in the annual report of the officer in charge for June 30, 1886 (Annual Report Chief of Engineers, 1886, page 2001). This

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amount has been added to that heretofore reported as required for the completion of the existing project.

An examination of the bar was made June 9, 1888, when the channel was found to have a depth of 11 feet at low water, and to be straight out on a line a little to the north of, but parallel to, the jetty.

The part of the jetty already constructed needs raising and strengthening. An extension shoreward of 600 feet or more will be needed to close the breach in the jetty tramway recently started and now widening at the shore end of the jetty.

July 1, 1887, amount available		$42,476.84
Amount refunded on account of errors in freight charges		20.55
		42,497.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$41,674.98	
July 1, 1888, outstanding liabilities	155.50	
		41,830.48
July 1, 1888, balance available		666.91
Amount appropriated by act of August 11, 1888		150,000.00
Amount available for fiscal year ending June 30, 1889		150,666.91
Amount (estimated) required for completion of existing project		318,970.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		319,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix R R 4.)

5. *Tillamook Bay and Bar, Oregon.*—This is a new work. To comply with the requirements of the river and harbor act of August 5, 1886, a preliminary examination and survey were made of Tillamook Bay and Bar, and the report thereon was transmitted to Congress February 25, 1888, and printed as House Ex. Doc. No. 185, Fiftieth Congress, first session.

The proposed improvement contemplates dredging, removal of snags, and closing with dams two small outlets, at an estimated cost of $5,192.19.

The river and harbor act of August 11, 1888, appropriates $5,200 for the work.

Amount appropriated by act of August 11, 1888	$5,200.00

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

It appearing, after preliminary examination by the local engineer, that the localities were worthy of improvement, Captain Powell was charged with and completed the survey of *Tillamook Bay and Bar, Oregon*, the results of which were transmitted to Congress and printed as House Ex. Doc. No. 185, Fiftieth Congress, first session.

(See also Appendix R R 5.)

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY—CONSTRUCTION OF CASCADES CANAL, COLUMBIA RIVER—IMPROVEMENT OF THE CHEHALIS RIVER; OF THE SKAGIT, STEILAQUAMISH, NOOTSACK, SNOHOMISH, AND SNOQUALMIE RIVERS, WASHINGTON TERRITORY—WATER-GAUGES ON COLUMBIA RIVER.

Officers in charge, Capt. Chas. F. Powell, Corps of Engineers, until April, 1888, since which date Maj. Thos. H. Handbury, Corps of

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Engineers. Lieut. Edward Burr, Corps of Engineers, has been on duty under the immediate orders of the officers in charge during the year. Supervising Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Mouth of the Columbia River, Oregon and Washington Territory.*—The project under which this work is being carried on was adopted in 1884. It contemplates providing a channel across the Columbia River Bar having a depth of 30 feet at mean low tide. This is to be accomplished by concentrating the water flowing over the bar and increasing the resultant currents to such a degree as to procure the desired depth.

Of late years the main-bar channel has varied from 19 to 21 feet in depth at low water, with insufficient width; 26 feet are required in a wide, direct, and stable channel, and 30 feet are desirable for the deep vessels needed by the Columbia River trade on account of heavy seas in the locality.

The work which is now in progress is the building of a low-tide jetty from Point Adams, on the South Cape, and extending in a westerly direction, with a slight curve to the south, out across Clatsop Spit. The project calls for this to extend 4½ miles or less as circumstances may require, to a point about 3 miles south of Cape Hannock. The material is principally stone, placed in position from a tramway resting on piles driven along the line of the jetty.

The jetty is now under construction for a little more than one-half a mile; over much of this distance only a thin layer of stone has yet been placed. The work is not sufficiently advanced to show any appreciable effect upon the channel over the bar.

The amount appropriated for this work is $287,500, of which there has been expended to June 30, 1888, $247,331.75.

July 1, 1887, amount available		$153,959.31
From sale of powder to appropriation improving Chehalis River, Washington Territory		78.00
		154,037.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$102,791.06	
July 1, 1888, outstanding liabilities	11,000.00	
		113,791.06
July 1, 1888, balance available		40,246.25
Amount appropriated by act of August 11, 1888		500,000.00
Amount available for fiscal year ending June 30, 1889		540,246.25
Amount (estimated) required for completion of existing project		2,923,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

(See Appendix S S 1.)

2. *Construction of canal at the Cascades, Columbia River, Oregon.*—The general scope of the improvement which it is desired to effect at the Cascades of the Columbia River includes a reach of about 4½ miles. The principal obstruction to navigation occurs at the upper end of this reach, at what is known as the Upper Cascades.

The project contemplates that the river should be improved below the Upper Cascades by removing bowlders and projecting points in the bed and banks, so as to give good navigable water from its lowest up to a 20-foot stage. The fall at the Upper Cascades is to be overcome by digging a canal about 3,000 feet in length across the neck of a low projecting spur, and placing in this a lock and suitable other structures

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which will permit of the passage of boats up to a 20-foot stage of water in the river. This lock to be so arranged that additional structures may be made which will permit navigation at higher stages. So far as is contemplated for the present the first part of the project is completed.

Up to the present time there have been excavated from the line of the canal in the neighborhood of 250,000 cubic yards of material of various kinds, such as bowlders, gravel, sand, and bed-rock conglomerate. To complete this with its lock structures and guard-gates, it is estimated that about 400,000 cubic yards of material of the same general character are yet to be moved.

About 40,000 cubic yards of dry stone wall and slope paving have been laid on the sides of the upper and lower entrances to the lock. A considerable quantity of concrete and rubble work has been done which was necessary to keep out water during process of construction. About 2,600 cubic yards of stone have been cut and prepared for use in the further construction of the entrance-walls.

The principal operations during the year were the excavation of about 22,645 cubic yards of material, making concrete and rubble masonry, cutting stone for side-walls and caisson masonry, and paving side-walls.

The amount appropriated for this work is $1,442,500, of which $1,140,451,06 has been expended.

July 1, 1887, amount available	$79,827.38
From sale of condemned property	10.00
	79,837.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	77,788.44
July 1, 1888, balance available	2,048.94
Amount appropriated by act of August 11, 1888	300,000.00
Amount available for fiscal year ending June 30, 1889	302,048.94
Amount (estimated) required for completion of existing project	1,550,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix S S 2.)

3. *Chehalis River, Washington Territory.*—The project for the improvement of this river consists in removing logs, snags, and other obstructions from its bed and banks, so as to provide a navigable channel-way during its medium and higher stages from Claquato, a small stream near its headwaters, to Gray's Harbor, into which it empties. This distance is between 80 and 100 miles.

Montesano, 12 miles from its mouth, is the head of coasting navigation. Eighteen feet at high tide can be carried to this point. The head of tide is at Elma, 16 miles above Montesano. Between these points navigation is obstructed by snags and fallen trees. By removing these a good all-the-year-round channel can be provided from Elma to the mouth. Above Elma the river, during summer and fall, is practically blockaded by snags, rafts, and shoals. These latter, in many cases, are reported to have but from 6 to 12 inches of water on them.

During the year 353 snags and 129 overhanging trees were removed. Eighteen thousand dollars has been appropriated for this work of which $7,960.83 has been expended.

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July 1, 1887, amount available		$1,269.94
Received from sale of fuze and caps to appropriation, improving Skagit and other rivers, Washington Territory		15.54
		1,285.48
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,244.97	
July 1, 1888, outstanding liabilities	1.34	
		1,246.31
July 1, 1888, balance available		39.17
Amount appropriated by act of August 11, 1888		2,000.00
Amount available for fiscal year ending June 30, 1889		2,039.17
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		3,000.00

(See Appendix S S 3.)

4. *Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Washington Territory.*—The project for the improvement of these rivers contemplates the removal of logs, snags, trees, and other obstructions to their navigation. There is provided for this purpose a snag-boat partially complete with an outfit of tools and appliances, which passes from one river to the other doing services in each as far as the necessities of the commerce require and the amounts appropriated will admit. The aggregate navigable length of the rivers is about 250 miles.

During the year 708 snags were removed from the Snohomish and Snoqualmie rivers.

Fifty-seven thousand five hundred dollars has thus far been appropriated for these rivers, of which $42,398.67 has been expended up to July 1, 1888.

July 1, 1887, amount available		$3,829.54
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,727.39	
July 1, 1888, outstanding liabilities	.82	
		3,728.21
July 1, 1888, balance available		101.33
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,101.33
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		12,000.00

(See Appendix S S 4.)

5. *Gauging waters of Columbia River.*—The object of these gaugings is to keep a record of the fluctuations of the Columbia River which will be used in connection with its improvement at various points. By the gauges established at various points, the pilots, captains, and those interested in navigation are enabled to ascertain the stage of water at all times on the crossings and places of difficult navigation, and to regulate the movement and draught of their vessels accordingly. An automatic self-registering gauge at Astoria has been found to be useful in indicating, in a general way, the condition of the bar at the mouth of the river, besides giving much data from which the tide tables are constructed.

To maintain these constantly a yearly appropriation of $2,000 will be necessary.

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July 1, 1887, amount available	$45.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	45.20
Amount appropriated by act of August 11, 1888	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

(See Appendix S S 5.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENTS TO COMPLY WITH REQUIREMENTS OF THE RIVER AND HARBOR ACT OF AUGUST 5, 1886.

The required preliminary examinations of the following localities were made by the local engineer in charge, Captain Powell, and reported by him as not worthy of improvement:

1. *Wood River, Oregon.*—(See Appendix S S 6.)
2. *Link River, Oregon.*—(See Appendix S S 7.)

The results of the above were transmitted to Congress and printed in House Ex. Doc. No. 58, Fiftieth Congress, first session.

IMPROVEMENT OF COLUMBIA AND WILLAMETTE RIVERS BELOW PORTLAND, OREGON; OF UPPER WILLAMETTE, UPPER COLUMBIA AND SNAKE, AND COWLITZ RIVERS, OREGON AND WASHINGTON TERRITORY.

Officer in charge, Maj. W. A. Jones, Corps of Engineers; Supervising Engineer, Col. G. H. Mendell, Corps of Engineers.

1. *Columbia and Lower Willamette rivers, below Portland, Oregon.*—The project for this improvement was adopted in 1877, and modified subsequently, the object being to afford a ship-channel of 20 feet depth at low water by contraction and shore protection works at four bars between Portland and Columbia City, Oregon, by temporary improvement at the bars during construction of the works, by temporary improvement at three shoal places below Columbia City, and by snagging operations.

The natural depth of the channel at the shoalest places was about 9 feet, and on six other bars it was from 10½ to 15½ feet at low water.

The amount expended on the project to June 30, 1888, was $447,040.98, and has resulted in maintaining a channel depth of successively 17, 18, and 19 feet at low water from Astoria over the whole reach of 100 miles.

Operations during the year have been practically suspended. A snag-boat has been constructed at a cost of $19,560. Minor surveys have been made with a view to watch the development of the dike channel at St. Helen's Bar. A channel was dredged across this bar early in October, 1887, at the expense of the Board of Trade of the city of Portland, Oregon; cost, $3,500.

An examination into the subject of the salmon fisheries of the Columbia and their relation to navigation was made under a resolution of Congress, and report submitted under date of December 21, 1887.

Sixty cubic yards of dangerous rock were removed from the Ross Island Channel in Portland Harbor.

Generally, the river constructions, floating property, and plant have been watched and cared for, but at considerable expense.

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July 1, 1887, amount available		$24,604.05
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$15,576.79	
July 1, 1888, outstanding liabilities	127.67	
July 1, 1888, amount covered by existing contracts	7,185.00	
		22,889.46
July 1, 1888, balance available		1,714.59
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		101,714.59
Amount (estimated) required for completion of existing project and maintenance		325,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

(See Appendix T T 1.)

2. *Of Upper Willamette River, Oregon.*—The project for this improvement was adopted in 1870, modified in 1878, and extended in later years. The object is to afford and maintain an easy, light-draught navigation from Portland to Eugene City, Oregon, and in 12 miles of tributaries, making in all a distance of 184 miles. The work consists in snagging operations, bar-scraping, and for the reach between Willamette Falls and Corvallis, in the contraction of water-way by low cut off dams and rock removal. The natural channel from Portland to Willamette Falls, 12 miles, was generally deep and wide, above it is narrow, tortuous, and much obstructed. The mouth of the Yamhill, 28 miles from the Falls, was the head of an inconvenient low-water navigation in a draught of 2½ feet. Only 1 foot could be carried above.

Present project was adopted in 1878.

Total appropriation to date is $84,000.

Amount expended $83,996.77, of which about $25,000 has been applied to maintenance.

No work has been done during the year.

July 1, 1887, amount available		$2,910.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$2,563.36	
July 1, 1888, outstanding liabilities	344.14	
		2,907.50
July 1, 1888, balance available		3.23
Amount appropriated by act of August 11, 1888		29,000.00
Amount available for fiscal year ending June 30, 1889		29,003.23

(See Appendix T T 2.)

3. *Upper Columbia and Snake rivers, Oregon and Washington Territory.*—The plan for this improvement, adopted in 1877, consists in rock removal at a number of very swift rapids to give channel depths at low water of 5½ feet upon the Columbia and 4½ feet upon the Snake; a river length of 266 miles between Celilo, on the Columbia, and Lewiston, on the Snake. The natural channel was narrow, tortuous, and dangerous, with many very difficult rapids.

The amount expended to June 30, 1888, is $126,000, and has resulted in improvement of fifteen different localities.

No work has been done during the year.

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Amount appropriated by act of August 11,1888 ..... $10,000.00

Amount (estimated) required for completion of existing project.....	16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	16,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T T 3.)

4. *Lower Clear Water River, Idaho.*—The present project, adopted in 1878, is to make a channel through rock-reefs and cobble-stone bars from Lewiston, at the mouth of the river, to North Fork, a distance of 40 miles, to secure a low-water draught of 4 feet.

The amount expended to June 30, 1888, is $15,000, and has resulted in improvement, more or less complete, over the lower reach of 30 miles.

Amount (estimated) required for completion of existing project	$19,424.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T T 4.)

4. *Cowlitz River, Washington Territory.*—The project for this improvement, adopted in 1880, consists in wing-dam construction, bar-scraping, and snagging operations to secure a light-draught navigation up to Toledo, a little more than 30 miles above the mouth.

The original estimate for this work was $3,000 for construction in the first year and an annual expenditure thereafter of $2,000 for maintenance by snagging operations.

The total appropriation to date is $8,000. The amount expended to date is $8,000.

No work was done during the year.

Amount appropriated by act of August 11, 1888..... $3,000.00

Amount (estimated) required for completion of existing project....Indeterminate	
Amount that can be profitably expended in fiscal year ending June 30, 1890	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix T T 5.)

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS.

For examinations and surveys for improvement, and for contingencies and for incidental repairs of harbors for which there is no special appropriation, an appropriation of $175,000 should be made, of which sum $75,000 for surveys and $100,000 for contingencies, including incidental repairs of harbors.

MISSISSIPPI RIVER COMMISSION.

This Commission, organized under the provisions of the act of Congress of June 28, 1879, reports to and receives instructions from the Secretary of War through this office.

The Secretary of War transmitted to the House of Representatives, January 3, 1888, a report from the Commission showing the progress of its operations from July 1 to November 1, 1887. This report was printed as House Ex. Doc. No. 55, part 1, Fiftieth Congress, first session. (See also Appendix U U 1.)

The report of the Commission for the fiscal year ending June 30, 1888, embracing the following subjects, viz, (1) Surveys and examinations;

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(2) Construction; (3) Financial statement, and (4) Estimates, will be found in Appendix U U 2.

The estimate of funds required for the service of the Commission for the fiscal year ending June 30, 1890, is stated in the above report, as follows:

ESTIMATE OF FUNDS FOR THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

Sundry civil bill.

Mississippi River Commission.—For salaries, inspections, and traveling expenses of the Mississippi River Commission; for printing and telegraphing; for office expenses and miscellaneous	$35,000

River and harbor bill.

For surveys and examinations of the Mississippi River from the head of the Passes to its headwaters; continuing survey	150,000
For improving the Mississippi River from the head of the Passes to the mouth of the Ohio River	4,000,000
For work at—	
Columbus, Ky., continuing improvement	25,000
Hickman, Ky., continuing improvement	181,750
Greenville Miss., continuing improvement	230,000
Vicksburg, Miss., continuing improvement	125,000
New Orleans, La., continuing improvement	230,000
For rectification of Red and Atchafalaya rivers	300,000

MISSOURI RIVER COMMISSION.

This Commission, organized under the provisions of the act of July 5, 1884, reports to and receives instructions from the Secretary of War through this office.

The report of the Commission describing the operations in its charge for the fiscal year ending June 30, 1888, will be found in Appendix V V of this report.

The estimate of funds required for the service of the Commission for the fiscal year ending June 30, 1890, is stated in the above report, as follows:

1. For the improvement of Missouri River from its mouth to Sioux City	$1,000,000
2. For surveys and examinations	120,000
3. For office and traveling expenses and salaries of Commissioners	30,000
4. Re-appropriation for general survey of Missouri River of the item of $15,000, appropriated in the act of July 5, 1884, for survey of river above the falls	15,000
Total	1,165,000

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

1. *Report of the Board of Engineers relative to the construction of certain bridges across the Missouri, Mississippi, and Illinois rivers.*—Senate bill 275, authorizing the construction of bridges in certain parts of the above-mentioned rivers, having been referred to this office by the Committee on Commerce of the Senate for examination, a Board of Engineer Officers was constituted by order of the Secretary of War to report upon its provisions.

The report was transmitted to the Senate by the War Department March 7, 1888, and printed as Senate Ex. Doc. 120, Fiftieth Congress, first session.

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The Board, after giving the subject full and careful consideration, prepared in detail a bill to meet the requirements of navigation and commerce and at the same time to do justice to the bridge interests. (See Appendix W W 1.)

2. *Bridge across Staten Island Sound known as Arthur Kill.*—To comply with a resolution of the Senate Committee on Commerce of February 9, 1888, requesting the Secretary of War to detail a Board of Engineers for the examination of the Arthur Kill Bridge, then in process of construction, especially in reference to its alleged obstruction to navigation, the Board so detailed completed the duty assigned to it and submitted two reports thereon April 10, 1888, the members being divided in opinion regarding the subject.

These reports, with a letter of transmittal from the Secretary of War, were transmitted to the Senate May 11, 1888, and printed as Senate Mis. Doc. 130, Fiftieth Congress first session. (See Appendix W W 2.)

3. *Report of a Board of Engineers on Senate bill No.* 1850, *Fiftieth Congress, first session, to authorize the construction of a bridge across the waters of Arthur Kill at or near the town of Westfield, Staten Island.*—(See Appendix W W 3.)

4. The plans and locations of the following bridges, authorized by law, have been approved by the Secretary of War:

a. Highway bridge across that part of the waters of Lake Champlain lying between the towns of North Hero and Alburgh, Vermont, authorized by act of Congress of June 20, 1884, approved by the Secretary of War January 13, 1887.—(See Appendix W W 4.)

b. Bridge of the Kansas City, Topeka and Western Railroad Company across Missouri River, at Sibley, Missouri, authorized by act of Congress of July 3, 1884, approved by the Secretary of War April 12, 1887.—(See Appendix W W 5.)

c. Bridge of the Chicago, Saint Louis and New Orleans Railroad Company across the Ohio River at East Cairo, Kentucky, authorized by acts of Congress of December 17, 1872, and February 14, 1883, authorizing the construction of bridges across the Ohio River. Approved by the Secretary of War April 15, 1887.—(See Appendix W W 6.)

d. Free wagon bridge across the Cumberland River, near the city of Nashville, Tennessee, authorized by act of Congress of March 3, 1887. Approved by the Secretary of War May 28, 1887.—(See Appendix W W 7.)

e. Bridge of the Ohio River Railroad Company across Great Kanawha River, near Point Pleasant, W. Va., authorized by act of Congress of March 3, 1887, for the construction of bridges across the Great Kanawha River below the Falls. Approved by the Secretary of War, June 14, 1887.—(See Appendix W W 8.)

f. Bridge across the west channel of the Detroit River, to connect Belle Isle Park with the main land, authorized by act Congress of July 20, 1886. Approved by the Secretary of War June 14, 1887.—(See Appendix W W 9.)

g. International bridge of the Sault Sainte Marie Bridge Company across Sainte Marie River, authorized by act of Congress of July 8, 1882. Approved by the Secretary of War June 28, 1887.—(See Appendix W W 10.)

h. Bridge of the Nebraska Railway Company across Missouri River at Nebraska City, authorized by act of Congress of June 4, 1872. Approved by the Secretary of War July 5, 1887.—(See Appendix W W 11.)

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i. Combined railway and wagon bridge of the Omaha and Council Bluffs Railway and Bridge Company across Missouri River between Omaha, Nebraska, and Council Bluffs, Iowa, authorized by act of Congress of March 3, 1887. Approved by the Secretary of War July 19, 1887.—(See Appendix W W 12.)

j. Bridge of the New York and Long Island Bridge Company across the East River between the city of New York and Long Island, authorized by act of Congress of March 3, 1887. Approved by the Secretary of War October 3, 1887.—(See Appendix W W 13.)

k. Bridge of the Ohio Valley Railway Company across the Tradewater River, Kentucky, authorized by act of Congress of February 21, 1887. Approved by the Secretary of War October 25, 1887.—(See Appendix W W 14.)

l. Bridge of the Sioux City Bridge Company across the Missouri River at Sioux City, Iowa, authorized by act of Congress of August 15, 1876. Approved by the Secretary of War March 18, 1888.—(See Appendix W W 15.)

m. Highway bridge of the Central Railway and Bridge Company of Newport, Kentucky, across the Ohio River between Cincinnati, Ohio, and Newport, Kentucky, authorized by acts of Congress of December 17, 1872, and February 14, 1883. Approved by the Secretary of War April 18, 1888.—(See Appendix W W 16.)

n. Bridge of the Georgia Pacific Railroad Company across the Sunflower and Yazoo rivers, authorized by act of Congress of March 3, 1887. Approved by the Secretary of War April 28, 1888.—(See Appendix W W 17.)

o. High bridge across the Mississippi River at Dubuque, Iowa, authorized by act of Congress of February 21, 1887. Approved by the Secretary of War April 30, 1888.—(See Appendix W W 18.)

p. Bridge of the Ohio Connecting Railway Company across the Ohio River near the mouth of Cork's Run, in Allegheny County, Pennsylvania, authorized by act of Congress of May 14, 1888. Approved by the Secretary of War June 18, 1888.—(See Appendix W W 19.)

q. Bridge of the Georgia Pacific Railway Company across the Tombigbee River at Waverly, Mississippi, authorized by act of Congress of March 3, 1887. (The act of April 2, 1888, changes the name of this company to railway instead of railroad.) Approved by the Secretary of War June 19, 1888.—(See Appendix W W 20.)

r. Bridge of the Memphis and Charleston Railroad Company across the Tennessee River at Chattanooga, Tennessee, authorized by act of Congress of February 28, 1887. Approved by the Secretary of War July 11, 1888.—(See Appendix W W 21.)

s. Bridge of the Kansas City and Memphis Railway and Bridge Company across the Mississippi River at Memphis, Tennessee, authorized by act of Congress of April 24, 1888. Approved by the Secretary of War August 23, 1888.—(See Appendix W W 22.)

REPORTS RESPECTING INTERFERENCES WITH NAVIGATION BY BRIDGES, CAUSEWAYS, AND OTHER STRUCTURES.

To comply with the requirements of section 2 of the river and harbor act of July 5, 1884, and of section 4 of the river and harbor act of August 5, 1886, the Secretary of War transmitted to Congress December 18, 1885, February 24, 1887, and December 10, 1887, copies of reports from officers in charge of river and harbor districts, made under orders from this office, of instances where bridges, causeways, and other

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structures erected or in process of erection do or will interfere with free and safe navigation.

These reports were printed as Senate Ex. Doc. 12, Forty-ninth Congress, first session; Senate Ex. Doc. 105, Forty-ninth Congress, second session, and House Ex. Doc. 12, Fiftieth Congress, first session.

(See also Appendix W W 23.)

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

To comply with the requirements of section 2 of the river and harbor act of July 5, 1884, and section 4 of the river and harbor act of August 5, 1886, the Secretary of War transmitted to Congress February 26, 1885, and January 3, 1888, communications from this office containing reports from officers in charge of river and harbor districts of instances in which piers, breakwaters, or other works built by the United States in aid of commerce or navigation are used, occupied, or injured by corporations or individuals, which reports were printed as House Ex. Doc. 259, Forty-eighth Congress, second session, and House Ex. Doc. 56, Fiftieth Congress, first session.

(See also Appendix X X.)

MISCELLANEOUS.

[Public works not provided for in acts making appropriations for the construction, repair, and preservation of works on rivers and harbors.]

MAINTENANCE AND REPAIRS OF WASHINGTON AQUEDUCT—INCREASING WATER SUPPLY OF THE CITY OF WASHINGTON—ERECTION OF FISH-WAYS AT THE GREAT FALLS OF THE POTOMAC.

Officer in charge, Maj. G. J. Lydecker, Corps of Engineers, with Lieut. C. McD. Townsend, Corps of Engineers, under his immediate orders.

1. *Washington Aqueduct.*—The appropriation of $20,000 has been applied as usual, to maintaining the aqueduct and its accessory structures in proper repair, and to regulating the supply of Potomac water to the cities of Washington and Georgetown.

In addition to the ordinary minor repairs and routine work considerable progress in extending the macadam roadway overlying and protecting the aqueduct was made, 4,682 cubic yards of broken stone having been applied to this purpose; the old dam across the Maryland Channel of the Potomac at the Great Falls was re-enforced by a backing of about 850 cubic yards of riprap carefully placed, and a new flooring of 3-inch Georgia pine was placed on the bridge spanning the waste-channel at the receiving reservoir.

July 1, 1887, amount available		$20,000.00
July 1, 1888, amount expended during fiscal year	$19,021.94	
July 1, 1888, outstanding liabilities	978.06	
		20,000.00

The sum of $20,000—being the same as that appropriated annually for the past nine years—is required for engineering, maintenance, and repairs of the aqueduct for the year ending June 30, 1890.

(See Appendix Y Y 1.)

2. *Increasing the water supply of the city of Washington, District of Columbia.*—The approved project for this work comprises, first, the

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extension of the dam at the Great Falls of the Potomac across Conn's Island and the Virginia Channel to the Virginia shore, and the completion of the whole to an elevation of 148 feet above mean high tide at the navy-yard, this elevation being about 15 inches above the crest of the old dam across the Maryland Channel of the river; second, the extension of the aqueduct by a tunnel 20,696.3 feet long, from the terminus of the conduit at Drover's Rest (distributing reservoir) to the site of the new reservoir near Howard University; third, construction of a new reservoir at that place capable of holding about 300,000,000 gallons; fourth, making the necessary main connections for taking the water from the new reservoir into the system of supply mains for the city.

Operations during the past fiscal year were confined to work on the *tunnel* and *new reservoir*, the dam having been completed in the summer of 1886, and the new mains laid to within a few feet of the proposed effluent gate-house at the new reservoir.

On the *tunnel* work was carried on until September 30, 1887, when the appropriation became exhausted, all work was stopped, and the tunnel allowed to fill with water. The deficiency act, approved March 30, 1888, appropriated the sum of $355,000 for completing the tunnel, and operations were at once resumed, but it was not until the latter part of May that work on the tunnel lining was well started. The length of tunnel lined during the year was 3,959½ feet, making, to June 30, 1888, the total length lined 10,069½ feet; the length of lining remaining to be done is 10,626.8 feet. The act of appropriation requires that the work appropriated for shall be completed by November 1, 1888, but it will be absolutely impossible to comply with this requirement, and it accordingly becomes a question whether further legislation by Congress will not be required to legalize expenditures made from this appropriation after the specified date.

On the *reservoir* the work under contract was completed by the end of October, 1887, the principal items of work accomplished during the year being about 45,000 cubic yards of excavation, and 7,500 square yards of slope paving. The construction of the combined influent and effluent gate-house, and the completion of the reservoir slopes in its vicinity, remains to be done before water can be let into the reservoir, but this can not be undertaken until the tunnel contractors finish operations at the inlet shaft and remove their plant from that point; this will probably be accomplished by the middle of August, 1888.

July 1, 1887, amount unexpended on all items of appropriations		$493,802.24
Amount appropriated by act of March 30, 1888		355,000.00
		848,802.24
July 1, 1388, amount expended during fiscal year, exclusive of outstanding liabilities	$298,607.59	
July 1, 1888, outstanding liabilities	43,908.08	
July 1, 1888, amount covered by existing contracts	283,522.50	
		626,038.17
July 1, 1888, balance available (less $611.24 disbursed directly from the United States Treasury Department for advertising)		222,764.07

At this writing it is believed that the above will suffice for the completion of the work in all its essential parts, and therefore no estimate is now submitted for any additional appropriation; it will ultimately be necessary to provide funds for properly finishing the grounds about the new reservoir, and for surface work at the several tunnel shafts, but the requisite amount can not be determined accurately at present, and

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the matter will be made the subject of a special communication at some later date.

(See Appendix Y Y 2.)

3. *Erection of fish-ways at Great Falls of the Potomac.*—No work has been done on the fish-ways during the past fiscal year, there being no sufficient appropriation for doing any useful work. The deficiency act approved February 1, 1888, appropriated $25,000 for their completion, but it has not yet been settled whether this appropriation is to be disbursed under the directions of the War Department or directly in the office of the United States Commissioner of Fish and Fisheries.

The original appropriation for the work was $50,000, of which there had been expended prior to June 30, 1888, the sum of $44,365.18, leaving $5,634.82 as the balance then available.

The money statement for the year ending June 30, 1888, is as follows:

July 1, 1888, amount available	$5,634.82
Amount appropriated by act of February 1, 1888	25,000.00
	30,634.82
July 1, 1888, outstanding liabilities for surveys in May and June, 1888	435.50
July 1, 1888, balance available	30,199.32

No estimate for further appropriation is submitted.

(See Appendix Y Y 3.)

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA.

Officer in charge, Lieut. Col. John M. Wilson, Corps of Engineers, colonel, U. S. Army.

1. *Improvement and care of public buildings and grounds in the District of Columbia.*—At the Executive Mansion the outside of the conservatory and a portion of the outside of the main building were repainted and a number of rooms and halls repainted and calcimined.

The tile floor of the main vestibule was repaired and the fresco work on ceiling and side walls cleaned and restored.

New carpets were placed in the green and blue parlors, and the furniture in the blue parlor, a portion of that in the east room, the green parlor, the southwest bed-room, and the upper corridor, which had become worn and shabby, was repaired; new matting was placed in the blue parlor and linoleum on the floors of the kitchen and pantry; a few articles of furniture were purchased and such curtains as were no longer fit for use were replaced with others; a storage closet was constructed in the attic; the ceiling over the south balcony, which was in a dangerous condition, was taken down and renewed.

The superstructure of one green-house, which was in poor condition, was renewed and various repairs were made to all the other green-houses. The entire sewerage of the Mansion was overhauled, and the chandeliers in the parlors and state dining-room were repaired and restored, as far as possible, to their original condition.

Extensive repairs were made to the green-houses at the nurseries and a new cold frame pit, 200 feet long, was constructed.

In addition to the general work performed for maintaining in good condition the improved public reservations, three heretofore partially improved have been highly improved; and of three heretofore unimproved, one has been highly and two partially improved.

The high iron fences have been removed from all the smaller trian-

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gular reservations, except one at the northwest corner of Pennsylvania avenue and Twentieth street, where the fence was allowed to remain for the present at the request of citizens living in the vicinity.

Extensive improvements were made at the grounds around new Pension Building and at the Smithsonian grounds. At the latter, 2,983 square yards of asphalt pavement was constructed on the main road between Seventh and Twelfth streets.

Asphalt walks were constructed leading to and around the Garfield statue.

A large amount of work was done at Reservation Number Seventeen. New roads were laid out and constructed, lawns graded and seeded, and a number of trees and shrubs planted.

Water was introduced into three reservations, the supply at the green-houses largely increased, and improvements made at the spring supplying the Capitol.

Attention is invited to the detailed report of the officer in charge and to his estimates and recommendations for the fiscal year ending June 30, 1890.

His estimates are as follows:

For improvement and care of public grounds	$133,788.50
For compensation of persons employed on public buildings and grounds	51,100.00
For replacing the overhead system of telegraph wires with duplicate six-conductor underground cable, and for care and repair of existing lines	10,000.00
For contingent and incidental expenses of public buildings and grounds	500.00
	195,388.50

(See Appendix Z Z 1.)

2. *Underground Telegraph and Telephone Wires.*—A resolution of the Senate of March 26, 1888, having directed the Superintendent of Public Buildings and Grounds to report to that body a comprehensive system of underground wires for telegraph and telephone service to connect the several Departments and Bureaus of the Government in Washington, a report from Col. John M. Wilson, in charge of public buildings and grounds, giving in detail the routes for, and extent of, such a system as would embrace all the required points, together with an estimate of its cost, was submitted, through this office, and printed as Senate Ex. Doc. No. 153, Fiftieth Congress, first session.

(See Appendix Z Z 2.)

3. *Washington Monument.*—By direction of the President, as contained in Special Orders No. 76, Headquarters of the Army, Adjutant General's Office, April 3, 1888, Col. John M. Wilson, U. S. Army, Lieutenant-colonel of Engineers, reported on the 4th of April, 1888, to the Joint Commission for the construction of the Washington Monument created by the act of Congress approved August 2, 1876, as the engineer in charge of the construction of the Monument, vice Col. Thos. Lincoln Casey, Corps of Engineers, relieved at his own request. By act of Congress, approved October 2, 1888, known as the sundry civil bill, the Joint Commission above referred to was dissolved at its own request, and the Secretary of War was charged with the custody, care, and protection of the Monument, and on October 6, 1888, the Secretary of War placed under the supervision of the Chief of Engineers the general charge of the same.

The last report made by Colonel Casey to the Joint Commission was dated December 1, 1887, and was submitted to Congress on December 17, 1887.

Since December 1, 1887, about 120,000 cubic yards of earth has been deposited in position, under contract, in constructing an earthen em-

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bankment around the Monument, making in all about 205,000 cubic yards deposited under the contract. The embankment when completed will contain about 267,412 cubic yards. The steam machinery and the electric-light plant have been put in running order, and the elevator and machinery connected therewith will be started at an early day.

The construction of a marble lodge-house, to be erected at the expense of the Washington Monument Society at a cost of $10,720, was commenced, under contract, early in April upon a site about 40 feet from the Monument, but its location having been subsequently changed, by direction of the Monument Commission, to a point about 480 feet east of the Monument, at an additional expense of $930, which was allowed the contractors by the Commission, work was suspended in May, but was resumed early in June at the new site, and has been continued in a satisfactory manner. At the close of September, 1888, the walls of the building were nearly completed.

During the present fiscal year it is proposed to continue the improvement of the grounds, to complete the new lodge, to insert in the walls of the Monument the memorial stones on hand, and to maintain in good order the machinery connected with the elevator and the electric lights.

Attention is invited to the detailed report of the officer in charge, and to his estimates for the fiscal year ending June 30, 1890.

His estimates are as follows:

For salaries of employés		$8,160.00
For fuel, light, contingencies, etc		2,340.00
		10,500.00
Balance on hand December 1, 1887		74,927.61
Amount appropriated by act of October 2, 1888		27,500.00
		102,427.61
Amount expended up to September 30, 1888	$44,853.02	
Amount covered by existing contracts	30,074.59	
		74,927.61
Amount available October 2, 1888		27,500.00

(See Appendix ZZ 3.)

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN THE YELLOWSTONE NATIONAL PARK.

The beginning of systematic construction of roads and bridges followed an appropriation of $40,000 made by act of Congress approved March 3, 1883, the portion of the appropriation allotted to construction work to be expended under the supervision and direction of an engineer officer to be detailed by the Secretary of War. The construction of roads and bridges has remained, since 1883, under the supervision of the Engineer Department.

The condition of the roads and bridges in the Park prior to the adoption in 1883 of a systematic project, which project, with such extensions as subsequent experience called for, constitutes the present one, was as bad as could be. The roads, few in number and short in extent, were mere wagon trails; the grades were frequently excessive, and the roads full of stumps, rocks, boggy places, and dangerous side-hill slants. The few bridges were of weak and cheap construction, and the crossings of the streams generally had to be made at fords, which, at time of high water, were impassable.

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The project for this improvement consists in repairing old trails, and in the construction of substantial roads about 18 feet in width, well crowned, ditched, and drained, with easy grades and, where necessary, covered with gravel or broken rock; also, the building of good bridges over the streams; the permanent roads to cover a circuit of about 145 miles, extending from the Park line at Gardiner, Mont., to the Mammoth Hot Springs, thence to Norris Geyser Basin, thence to Upper Geyser Basin, thence to Yellowstone Lake *via* Shoshone Lake, across the great continental divide of the Rocky Mountains, thence along the Yellowstone Lake and Yellowstone River, *via* the Falls and the Grand Cañon to Yancy's, thence to the Mammoth Hot Springs. In addition, a cross-road from the west line of the Park to the Firehole Basin, a road from Yancy's to the east line of the Park, and a number of short branch roads and trails from the intersection of the above-named roads to minor objects of interest off the main lines of travel; in all, about 225 miles of new road, about twenty large and fifty small bridges, and many culverts are contemplated in the project.

The cost of completion of the project was estimated in the last Annual Report as $250,000. Deducting from this the appropriation made by act approved March 3, 1887, the cost of completion reduces to $230,000.

Total expended upon the project to the close of the fiscal year ending June 30, 1888, $109,779.42.

The work performed under this project may be briefly stated as follows:

Miles of new road built	58½
Miles of old roads (original wagon trails) repaired	90
Miles of new roads repaired, about	45½
Number of large bridges built	6
Number of small bridges built	13

and many culverts.

Some of the new work was through heavy rock cutting. The sum of $130,000 asked for the fiscal year ending June 30, 1890, is to be expended towards completing the circuit of main road from the Mammoth Hot Springs *via* Upper Geyser Basin, Shoshone and Yellowstone lakes, the Falls and Yancy's, about 145 miles, of which 58½ miles have been completed; in improving and completing roads already built or commenced; in repairing old trails where absolutely necessary; in purchasing a portable saw-mill and rock crusher; and in building a warehouse for tools and supplies, a small office, a stable, and a house for the overseer in summer and the watchman in winter.

Owing to the late date at which appropriations are frequently made by Congress, the season when expenditures can be made to the best advantage is lost for the fiscal year; for that reason, in order that the work may be done at the most favorable time, it is earnestly recommended that future appropriations for this object be made without limit, as in the case of each of the items of river and harbor acts.

Amount appropriated by act of March 3, 1887		$20,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$19,716.84	
July 1, 1888, outstanding liabilities	283.16	
		20,000.00

Amount (estimated) required for completion of existing project	230,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	130,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

(See Appendix A A A.)

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ANNUAL WATER-LEVELS OF THE NORTHERN AND NORTH WESTERN LAKES.

A table showing the monthly means of water-levels from June 30, 1887, to June 30, 1888, at Charlotte, Erie, Cleveland, Milwaukee, Escanaba, Sand Beach, Marquette, and Sault Ste. Marie, being a continuation of that published in the last annual report, and also tables and diagrams showing yearly means of water-levels from 1860 to 1887, will be found in Appendix B B B 1.

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTH WESTERN LAKES.

Under the supervision of this office additions have been made to each of the following engraved chart plates:

North end of Lake Michigan;
Straits of Mackinac;
Beaver Island Group.

During the year 8,897 charts were issued under the supervision of Lieut. Col. O. M. Poe, Corps of Engineers, 1,527 of which were sold at 30 cents each, and the amount, $458.10, turned into the Treasury.

Owing to changes in channels, the discovery of previously unknown dangers, and the extension of works of river and harbor improvement, many of the charts require additions and corrections in order to render them of the greatest service. In some cases limited surveys will be required to obtain the requisite data. Considering the extensive use made of the charts and their recognized value to the lake marine, it is recommended that the sum of $10,000 be annually appropriated for the purpose of making the necessary surveys and for correcting the engraved plates, in addition to the amount appropriated for electrotyping the plates and for chart printing. The recommendations of last year are repeated in this respect.

Amount appropriated by act of March 3, 1887		$2,000.00
June 30, 1888, amount expended during the fiscal year		1,797.32
Amount required for survey of the northern and northwestern lakes for the fiscal year ending June 30, 1890, namely, for surveys, additions to and correcting engraved plates	$10,000.00	
For printing and issuing charts for use of navigators, and electrotyping plates for chart printing	3,000.00	
		13,000.00

(See Appendix B B B 2.)

MILITARY AND GEOGRAPHICAL MAPS.

A new edition of the map of the Department of the Columbia has been photo-lithographed and distributed.

RECONNAISSANCES AND EXPLORATIONS.

The following officers of the Corps of Engineers have been on duty at the headquarters of the military divisions and departments, engaged in preparing such maps and making such surveys as were required by their respective commanding officers:

Maj. Thomas H. Handbury, at headquarters Division of the Missouri, to April 5, 1888; since which date Capt. William L. Marshall.

Lieut. Thomas L. Casey, at headquarters Division of the Pacific and Department of California, to September 19, 1887.

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Lieut. John Biddle, at headquarters Department of Dakota, to December 15, 1887.

Lieut. William C. Langfitt, at headquarters Department of the Columbia.

Lieut. Hiram M. Chittenden, at headquarters Department of the Platte, from July 16, 1887.

Also, Lieut. James E. Runcie, First U. S. Artillery, acting engineer officer at headquarters Division of the Pacific.

Capt. W. L. Marshall, engineer officer, Military Division of the Missouri, reports that the work of his office has consisted in collecting, compiling, and platting geographical information for the improvement of existing maps and in making copies of maps of military and Indian reservations, posts, scouts, and reconnaissances for use at division headquarters.

(See Appendix C C C I.)

Lieut. William C. Langfitt, engineer officer, Department of the Columbia, reports the determination of the western boundary of the Vancouver Military Reserve to aid the post quartermaster in removing encroaching persons; an estimate for increased water supply for Fort Spokane, together with a resurvey of that reservation; a resurvey of the Fort Townsend Military Reservation. Many maps, plans, etc., have been prepared and issued to officers of the department.

The department map was corrected to December, 1887, and forwarded to the Chief of Engineers, to be used in preparing a new edition. A map of Alaska has been projected and its compilation started.

Additions and corrections are constantly being made to the department map to add to its efficiency and correctness.

(See Appendix C C C 2.)

Lieut. James E. Runcie, First U. S. Artillery, acting engineer officer, Division of the Pacific, reports that the following have been made:

Map of a portion of California south of Mojave Junction; drawings of plant and machinery used in the manufacture of high explosives; surveys for new water supply for Fort Gaston, Cal., and for a telegraph line thence to Arcata, with report; surveys for a sewerage system at Fort Huachuca, Ariz., with exhaustive report and drawings; that the land-office map of California has been corrected; the projection for the map for the Department of Arizona and the District of New Mexico calculated, and that for a new map of the Department of California calculated and laid out; and data collected for correcting the maps of the division, as well as for the correction and compilation of map of Fort McDermit, Nev., and Fort Bidwell, Cal.

(See Appendix C C C 3.)

Lieut. H. M. Chittenden, engineer officer, Department of the Platte, reports that the field work and work outside the office during the year has consisted of—

1. A survey, relocation, and marking of the boundaries of the Fort Niobrara Military Reservation.

2. A survey of the department rifle range, at Bellevue, Nebr.

3. Copying the records in the United States land-office at Cheyenne, Wyo., to obtain information for a department map.

4. Superintending the construction of a system of water-works for Fort Bridger, Wyo.

The office work has consisted of—

1. Preparation of a map of Fort Niobrara Military Reservation.

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2. Preparation of map of Bellevue Rifle Range.
3. Preparation of a plat showing collectively all the military posts and reservations in this department.
4. Preparation of a map of the Department of the Platte.
5. Usual routine work.

Twenty copies of the map of the United States published in 1885 have been received from the Chief of Engineers and distributed to posts and officers of the department. Several surveying and mathematical instruments have also been received.

(See Appendix C C C 4.)

ESTIMATE FOR AMOUNT REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DIVISIONS AND DEPARTMENTS.

For military surveys and reconnaissances and surveys of military reservations by the engineer officers attached to the several headquarters of military divisions and departments, being an average of $5,000 for each of eight military divisions and departments west of the Mississippi River, $40,000; for publication of maps for use of the War Department, $10,000; total, $50,000.

Attention is specially invited to this estimate for appropriation and to the important uses for which it is intended.

At the headquarters of the military departments west of the Mississippi River there are stationed officers of the Corps of Engineers, or other officers detailed to act, whose duty it is to make reconnaissances for military purposes, to make such surveys and prepare such maps as may be required by their respective commanding officers. In recent years no appropriations have been made for these purposes, and, consequently, these officers have been very much cramped from lack of the necessary means, and the usefulness of their offices has been very much reduced in consequence. The maps of these departments are constantly in need of revisions and additions, which the officers make so far as possible, but with no means even for the purchase of paper their efforts are limited in results.

Paragraph 464 of the Army Regulations requires that the commanding officer of each post where there are fixed batteries bearing upon a channel will call upon the Engineer Department for accurate charts showing the soundings, to the extent of the ranges of the guns.

During the last season of artillery practice at our coast fortifications calls upon this department to perform its duty under this regulation could not be honored from lack of means.

Maps of certain military departments are now being prepared, and should be published.

Besides all this there is much information in this office relative to military geography which could, with little expense, be made available for the information of officers of the Army; for instance, there are on the office files detailed maps of regions of Europe which may become at an early day the theaters of war, and it would be of great advantage to the service if such information as these maps give could be made available for the study of officers. Were the means provided this office would be glad to compile and to disseminate the information on its files.

It is the policy of this country to keep a standing army small in numbers, but it is its expectation that it should be a highly instructed one, and a small outlay as here referred to will be conducive to that end.

Applications from officers of the Army have been received for maps of certain regions of Europe, and it was with great regret that this

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office could not render this assistance to officers desirous of improving themselves professionally especially, when the material was on its files.

OFFICE OF THE CHIEF OF ENGINEERS.

During the fiscal year ending June 30, 1888, the following-named officers were in charge of the several divisions of the Office of the Chief of Engineers:

FIRST DIVISION.—*Fortifications and Surveys relating thereto—Armament of Fortifications—Sites for Engineer Defenses—Boards of Engineers for Defenses.*

SECOND DIVISION.—*Battalion of Engineers—Engineer School of Application and Engineer Depot and Post—Professional Papers and Information—Personnel—Orders—Military Reservations—Land Files.*

Maj. Charles W. Raymond, until January 27, 1888; Capt. Thomas Turtle, temporarily, to April 18, 1888; since which date Capt. Clinton B. Sears.

THIRD DIVISION.—*Improvement of Rivers and Harbors and Surveys relating thereto—Bridging Navigable Waters of the United States—Public Buildings and Grounds and Washington Aqueduct.*

Maj. James C. Post.

FOURTH DIVISION.—*Accounts for Disbursements—Contracts—Returns of Engineer Property and Instruments—Applications for Remittances—Appropriations and Estimates—Blank Forms.*

FIFTH DIVISION.—*Survey of the Lakes—Explorations and Surveys—Reconnaissances—Maps—Intruments—Claims.*

Capt. Thomas Turtle.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

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STATEMENT SHOWING THE RANK AND THE DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

RANK AND NAME.	DUTIES.
BRIGADIER-GENERAL AND CHIEF OF ENGINEERS.	
James C. Duane.....	In command of the Corps of Engineers and in charge of the Engineer Department. Charged with the supervision of such matters connected with construction of jetties and other works at South Pass, Mississippi River, as require the action of the Secretary of War. Member of Joint Commission to supervise the construction of the Washington National Monument. Member of the Light-House Board. Retired from active service on June 30, 1888, under the provisions of the act of Congress approved June 30, 1882.
COLONELS.	
Quincy A. Gillmore..... *Bvt. Major-General.*	In charge of Forts Wool, Va.; Caswell, N. C., Moultrie, Sumter, and Johnson, S. C.; Oglethorpe and Pulaski, Ga., and Clinch, Fla., and of the construction of Forts Wadsworth, Tompkins and its batteries, N. Y.; Monroe, Va., and Castle Pinckney, S. C. In charge of the improvement of the harbors at Charleston, S. C., and Savannah and Brunswick, Ga. In charge of the improvement of Ashley River and Wappoo Cut, S. C.; Cumberland Sound, Ga. and Fla.; Savannah and Altamaha rivers, and Romerly Marsh, Ga., and Edisto and Salkahatchie rivers, S. C. In charge of preliminary examinations of Savannah River from Doboy Island to Doboy Bar, Ga., and North Fork of the Edisto River, S. C. In charge of preliminary examinations and surveys of Savannah River from crosstides above Savannah to the bar; of Jekyl Creek, Ga., and of Mosquito Creek between the South Edisto and Ashepoo rivers, S. C. In charge of removal of wreck of trading boat in Cheehaw River, and of steamer *Alice Clark*, from the channel of inside passage below Charleston, S. C. Member of Board of Visitors for Engineer School of Application, at Willets Point, N. Y. Member of Boards of Engineer Officers on further improvement of Cape Fear River, N. C., and on improvement of the Potomac River in vicinity of Washington, D. C. Member of Board of Officers to examine into and report upon question of source and method of water-supply, sewerage, etc., at Willets Point, N. Y. Member and President of the Mississippi River Commission created by act of Congress approved June 28, 1879. His death at Brooklyn, N. Y., April 7, 1888, announced in General Orders No. 5, Headquarters Corps of Engineers, April 10, 1888.
Thos. Lincoln Casey....	Member and President of The Board of Engineers. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. In charge of the construction of the building for the State, War, and Navy departments and of the Washington National Monument. Member

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
COLONELS. (continued.)	
	of the Light-House Board. Member of Boards of Engineer Officers on the construction of bridges across Staten Island Sound (known as Arthur Kill), and the Kill Von Kull, and for the examination of certain named officers of the Corps of Engineers, with view to their promotion.
John G. Parke..... *Bvt. Major-General.*	On duty in office of the Chief of Engineers. Detached; Superintendent of the Military Academy. Member of Board for the purpose of considering the limits on the south of the reservation at the Post of West Point, N. Y.
George H. Mendell.....	In charge of Fort Winfield Scott, Fort on Alcatraz Island, batteries at Fort Mason, and defenses at Lime Point, and fortifications at Angel Island, San Francisco Bay, and at San Diego, Cal. Supervising Engineer over districts embracing works in charge of Majors Benyaurd, Jones, Heuer, and Handbury, and Captains Powell, Payson, and Young. In charge of the improvement of the harbors at Oakland and Redwood, Cal. To investigate causes tending to decrease depth of water and diminish the commercial value of San Francisco Harbor. In charge of survey of San Francisco Harbor, San Pablo and Suisun bays, Strait of Carquinez, and mouths of San Joaquin and Sacramento rivers, Cal. In charge of the removal of wreck of steamer *Escambia* from entrance to San Francisco Harbor.
Henry L. Abbot..... *Bvt. Brig. General.*	Member of The Board of Engineers. In charge of certain experiments with torpedoes. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member of Board of Officers and Civilians to examine and report at what ports fortifications or other defenses are most urgently required, etc. In temporary charge of Forts Wool, Va.; Caswell, N. C.; Moultrie, Sumter, and Johnson, S. C.; Oglethorpe and Pulaski, Ga., and Clinch, Fla., and of the construction of Forts Wadsworth, Tompkins and its batteries, N. Y.; Monroe, Va., and Castle Pinckney, S. C. In temporary charge of the improvement of the harbors at Charleston, S. C., and Savannah and Brunswick, Ga. In temporary charge of the improvement of Ashley River and Wappoo Cut, S. C.; Cumberland Sound, Ga. and Fla.; Savannah and Altamaha rivers, and Romerly Marsh, Ga., and Edisto and Salkahatchie rivers, S. C. In temporary charge of preliminary examination of North Fork of the Edisto River, S. C.
	In temporary charge of removal of wreck of trading boat in Cheehaw River, and of wreck of steamer *Alice Clark* from the channel of inside passage below Charleston, S. C. To examine and report upon the site of the new bride across Arthur Kill. Member of Boards of Engineer Officers to consider and report upon location and plans of bridge across the Mississippi River at Dubuque, Iowa, and for the examination of certain named officers of the Corps of Engineers, with view to their promotion.
William P. Craighill....	Member of The Board of Engineers. In charge of Fort Carroll and the construction of Fort McHenry, Md. Supervising engineer over districts embracing works in charge of Captains Hinman, Bixby, and Black, Lieutenants Abbot and Carter, and Mr. S. T. Abert. In charge of the improvement of the harbors at Baltimore and Annapolis, Md. In charge of harbor of refuge at mouth of Great Kanawha River, West Virginia. In charge of the im-

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
COLONELS. (continued.)	
	provement of James River, Virginia, and New River, Virginia and West Virginia, and Great Kanawha and Elk Rivers, West Virginia, and of the work of rebuilding piers at Battery Island, head of Chesapeake Bay. In charge of the survey across the peninsula of Maryland and Delaware to connect by canal the waters of the Delaware and Chesapeake bays. In charge of preliminary investigation of Coal River, West Virginia. In charge of preliminary investigations and surveys of Meadow and Gauley rivers, West Virginia. In charge of removal of wreck of schooner *Dorcas and Eliza* from Pasquotank River, near Elizabeth City, N. C., and of barge *Harry* off Turkey Point light-house, Chesapeake Bay. To exercise supervision of construction of bridge across Great Kanawha River at Point Pleasant, W. Va. Member of boards of engineer officers on further improvement of Cape Fear River, N. C.; on improvement of the Potomac River in vicinity of Washington, D. C.; on subject of permanent improvement of Delaware River and Bay; on construction of the locks at the Cascades, Columbia River, Oregon; and to consider and report upon Joint Resolution (H. Res. 113) in relation to the Delaware River between the city of Philadelphia, Pa., and Camden, N. J. Member of Advisory Board to State Harbor Commission of Norfolk, Portsmouth, and Norfolk County, Va. In temporary charge of the improvement of the harbor at Norfolk, and the approach to Norfolk Harbor and the United States Navy Yard, Va. In temporary charge of the improvement of the Blackwater, Nottoway, Archer's Hope, and Appomattox rivers, Va., and Meherrin River, Currituck Sound, Coanjok and Edenton bays, and North River Bar, N. C., and North Landing River, Va. and N. C. In temporary charge of preliminary examination of Alligator River, N. C., and preliminary examination and survey of Nansemond River, Va.
Cyrus B. Comstock ..... *Bvt. Brig. General.*	Member of The Board of Engineers. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member of Boards of Engineer Officers on further improvement of Cape Fear River, N. C.; on improvement of the Potomac River in vicinity of Washington, D. C.; on harbor at Atlantic City, N. J.; to consider and report upon joint resolution (H. Res. 113) in relation to the Delaware River between the city of Philadelphia, Pa., and Camden, N. J.; and for the examination of certain named officers of the Corps of Engineers, with view to their promotion. Member and President of the Mississippi River Commission created by act of Congress approved June 28, 1879.
LIEUTENANT-COLONELS.	
Orlando M. Poe ..... *Bvt. Brig. General.*	In charge of the construction of Fort Wayne, Mich. In charge of the improvement of the harbors at Cheboygan and Au Sable, on Lake Huron, and Alpena, at Thunder Bay, and of the construction of harbor of refuge on Lake Huron; of the improvement of the St. Mary's Falls Canal and River, and of the rivers Detroit, Saginaw, and Clinton, Mich., and Hay Lake Channel of the St. Mary's River; of removing bar at ice-harbor of refuge at Belle River, Mich., and construction of Dry Dock. St. Mary's Falls

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	Canal. In charge of St. Clair Flats Canal and St. Mary's Falls Canal, Mich. In charge of issuing charts of Northern and Northwestern lakes, and of water-level observations on Lake Huron. In charge of preliminary examinations of bar in St. Clair River, opposite Saint Clair City, North River between Essex and North bridges, Biddle's Point at Mackinac Harbor, Harbor at Forestville, Lake Huron, and Pinepog River, Mich. In charge of preliminary examinations and surveys of Rouge River at its junction with Detroit River, and up the river to the bridge of the Saint Louis and Wabash Railroad; and of mouth of Black River, Mich. In charge of survey of historic grounds, etc., referred to in the act of Congress approved May 24, 1888. To supervise and personally examine the construction of bridge across the west channel of the Detroit River to connect Belle Isle Park with the mainland, and to exercise supervision of construction of bridge across Sainte Marie River, Mich. Member of Boards of Engineer Officers upon plan and estimate for a lock at or near the Lower Island at Nashville, for improving Cumberland River, Tenn., and to examine and report upon plans and location of proposed bridge across the Ohio River between Cincinnati, Ohio, and Newport, Ky.
David C. Houston..... *Bvt. Colonel.*	Member of The Board of Engineers. In charge of Forts Griswold and Hale, Conn., and Lafayette, N. Y., and of the construction of Forts Trumbull, Conn., and Columbus, Wood, Wadsworth, and Tompkins and its batteries, N. Y.; Castle Williams, South Battery, new Barbette Battery and sea-wall at Governor's Island, N. Y., and of permanent platforms for modern cannon of large caliber. In charge of the improvement of the harbors of New London, Clinton, New Haven, Milford, Bridgeport, Black Rock, Southport, Stamford, and Norwalk, Conn., and Port Jefferson, Greenport, Mamaroneck, Port Chester, New Rochelle, and of Echo Harbor, N. Y., and of the construction of breakwater at New Haven, Conn. In charge of the improvement of the rivers Housatonic and Thames, Conn., Connecticut, Mass. and Conn., Flushing Bay, and East Chester Creek, N. Y. In charge of the manufacture and supply of mastic. In charge of preliminary examination of Peter's Neck Bay, N. Y. In charge of preliminary examinations and surveys of Five Mile River and Duck Island harbors, Conn., and Glen Cove Harbor, N. Y. In charge of removal of wreck of scow *George C. Bloomer* in Connecticut River at Hartford, Conn.; of wreck of schooner *R. H. Daly* in Connecticut River near Saybrook Point; of wreck of schooner *Emma J. Higgins*, near Penfield's Reef, and of wreck of schooner *Louise Bliss*, at Cornfield Shoal, Long Island Sound. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y.
George H. Elliot.....	On sick leave of absence.
Henry M. Robert.....	In charge of Fort Mifflin, Pa., and mortar battery thereat; Fort Delaware, and fort and mortar battery opposite Fort Delaware, Del., battery and mortar battery at Finn's Point, and site for defenses at Red Bank, N. J. In charge of the improvement of the harbor at Delaware Breakwater; ice-harbors at Marcus Hook, Pa., and the head of Delaware Bay; of the Salem, Rancocas, and Raccoon rivers, and Cohansey, Mantua, and Woodbury creeks,

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	N. J.; Frankford Creek and Schuylkill River, Pa.; and Delaware River, from Trenton, N. J., to its mouth; and of the construction of pier near Lewes, Del. In charge of preliminary examinations of channel back of Brigantine Beach, between Absecon and Brigantine inlets, N. J., and Darby Creek, Pa. In charge of preliminary examination and survey of thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J. In charge of survey of thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J. In charge of removal of wreck of schooner *David Lee* from Delaware Bay; of wreck of schooner *G. H. Bent* from the harbor at Delaware Breakwater, Del., and of wreck of steamer *Blanche Henderson* from Delaware River, off Lombard street wharf, Philadelphia, Pa. Member and Disbursing Officer of Board of Engineer Officers on harbor at Atlantic City, N. J. Member of Boards of Engineer Officers on subject of permanent improvement of Delaware River and Bay; on the construction of bridges across Staten Island Sound known as Arthur Kill), and the Kill Von Kull; and to consider and report upon Joint Resolution (H. Res. 113) in relation to the Delaware River between the city of Philadelphia, Pa., and Camden, N. J. Member of Commission Advisory to Board of Harbor Commissioners of Philadelphia.
William E. Merrill..... *Brt. Colonel.*	In charge of the improvement of the Ohio River; Monongahela River, W. Va.; Allegheny River, Pa., and of the Muskingum River, Ohio. In charge of the construction of harbors of refuge at mouth of Muskingum River, near Cincinnati, Ohio, and of a dam at Herr's Island, Pa. In charge of preliminary examinations for ice-harbor at Paducah, and of bar at mouth of Limestone Creek, in harbor of Maysville, Ky. In charge of preliminary examinations and surveys of Ohio River, near Evansville, Ind., and of the Big Hockhocking River, from mouth to Coolville, Ohio. In charge of removal of wrecks of two barges from the Ohio River, at Glasshouse Ripple, near Pittsburgh, Pa. To exercise supervision over the construction of bridges across the Ohio River between Covington and Cincinnati; at Cairo; between Cincinnati and Newport; and near the mouth of Cork's Run, in Allegheny County, Pa. To inspect the work in progress for improvement of Coosa River, Ga. and Ala. In temporary charge of the improvement of the Little Kanawha, Guyandotte, and Buckhannon rivers, W. Va., and the Big Sandy River, W. Va. and Ky., and of preliminary examination and survey of Louisa Fork of Sandy River, Va. Member of Boards of Engineer Officers on plan and estimate for a lock at or near Lower Island at Nashville, for improving Cumberland River, Tenn.; to consider and report upon new plans for the proposed bridge across the Ohio River, near Pittsburgh, Pa.; to consider and prepare general regulations concerning the erection of bridges over the Muskingum River, Ohio; to consider and report upon the improvement of the Mississippi River from Des Moines Rapids to the mouth of the Illinois River; to recommend a plan for the improvement of the navigation at the mouth of the Cumberland River; on proposed bridge across the Ohio River at Louisville, Ky., and on proposed bridge across the Mississippi River at Memphis, Tenn. Engineer 14th Light-house District.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
Walter McFarland.....	Member of The Board of Engineers. In charge of Fort at Sandy Hook, N. J., and of the construction of Fort Hamilton and additional batteries, and Mortar Battery at Fort Hamilton, N. Y. In charge of the improvement of the harbors of New York, Rondout, and Saugerties, N. Y. In charge of the improvement of the Hudson and Harlem rivers and Sheepshead and Canarsie bays, N. Y.; Raritan Bay, N. J.; channel in Gowanus Bay and Buttermilk Channel; channel between Staten Island and New Jersey, and deepening Gedney's Channel, and Newtown Creek and Sumpawanus Inlet, N. Y. In charge of the removal of obstructions in East River and Hell Gate, N. Y. In charge of removal of wreck of sloop *Locomotive* in Hudson River, and of wreck of bark *Quickstep* in Main Ship Channel, New York Harbor, and of wreck of canal-boat from Harlem River at High Bridge. In charge of preliminary examination of channel between Jamaica Bay and Rockaway Inlet, and of the East River, N. Y. In charge of preliminary examinations and surveys of Hudson River between New Baltimore and Coxsackie, and of the mouth of Patchouge River, N. Y. In charge of preliminary examination or survey of Spring Creek, N. Y. To exercise supervision over construction of bridge across the East River between the city of New York and Long Island. Member of Board of Visitors for Engineer School of Application at Willets Point, N. Y. Member of Boards of Engineer Officers on subject of permanent improvement of Delaware River and Bay, and on harbor at Atlantic City, N. J. Inspected the works of river and harbor improvement in charge of Majors Ernst and Damrell and Captains Hoxie, Taber, and Black.
John M. Wilson ..... *Bvt. Colonel.*	In charge of Public Buildings and Grounds in the District of Columbia, with the rank of Colonel. In charge of the improvements over the grave of Thomas Jefferson at Monticello, Va.; of the erection of a pedestal and statue of the late President James A. Garfield; of a monument at Washington's Headquarters, at Newburgh, N. Y.; of the erection of a monument to mark the birth-place of George Washington; of the erection of building for the Army Medical Museum and Library, and of the erection of monuments or memorial tablets for the proper marking of the position of each of the commands of the Regular Army engaged at Gettysburg. In charge of the construction of the Washington Monument. To report to the United States Senate a comprehensive system of underground wires, for telegraph and telephone service, to connect the several Departments and Bureaus of the Government in Washington City. Member of Board of Engineer Officers in connection with the Bennington Battle Monument.
John W. Barlow.....	In charge of the improvement of the rivers Tennessee, Tenn., Ala., and Ky.; Cumberland above and below Nashville, Ky. and Tenn.; Hiawassee, Caney Fork, Duck, French Broad, Clinch, and Little Tennessee, Tenn., and South Fork of the Cumberland, Ky. In charge of preliminary examinations and surveys of Obey's River from the point where improvements have heretofore been made to the mouth of the West Fork, Tenn., and of Bear Creek, Miss. Member of Boards of Engineer Officers to consider and report upon new plans for the proposed bridge

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	across the Ohio River near Pittsburgh, Pa., and to consider and recommend a plan for the improvement of the navigation at the mouth of the Cumberland River.
Peter C. Hains	In charge of Forts Foote and Washington, Md., and Wool, Va., and the construction of Fort Monroe, Va. In charge of the improvement of the harbors at Washington and Georgetown, D. C. In charge of the improvement of the Potomac River in the vicinity of Washington, D. C., the establishment of the harbor lines, and the raising of the river flats. In charge of the construction of a new wharf at Fort Monroe, Va. In charge of the improvement of the Shenandoah River, W. Va. In charge of purchase and reconstruction of Aqueduct Bridge, D. C. In charge of construction of bridge across the Eastern Branch of Potomac River, D. C. In charge of survey of the low lands at Washington Barracks, D. C. To test samples of cement offered for use of Congressional Library Building. To supervise the modifications of the Light-house Wharf at Fort Monroe, Va. To report upon a new sewer system at Fort Monroe, Va. Member of Board of Officers on division of land at Fort Monroe, Va., with view to consolidating, separately, the belongings of the Engineer Corps and the Ordnance Departments. Member of Boards of Engineer Officers in connection with the Bennington Battle Monument, and on the construction of bridges across Staten Island Sound (known as Arthur Kill) and the Kill Von Kull.
George L. Gillespie.....	In charge of Forts Winthrop, Standish, Andrew, Independence, and work on Long Island Head, and of the construction of Fort Warren, Mass. In charge of the improvement of the harbors at Newburyport, Lynn, Boston (including sea-walls on Point Allerton, Great Brewster Island, Lovell's Island, Gallop's Island, Long Island Head, Rainsford Island, and Deer Island; Malden, Mystic, and Charles rivers; and channel leading to Nantasket Beach), Provincetown, Plymouth, Scituate, Hingham, and Gloucester, Mass. In charge of construction of a national harbor of refuge (of the first class) at Sandy Bay, Cape Ann, Mass. In charge of the improvement of the rivers Merrimac and Ipswich, Mass. In charge of preliminary examinations and surveys of Manchester, Duxbury, Wellfleet, and Winthrop Harbors, Mass. To mark the boundaries of the military reservation of Fort Sewall, Mass., with suitable monuments. Member of Boards of Engineer Officers on subject of permanent improvement of Delaware River and Bay; on construction of the locks at the Cascades, Columbia River, Oregon; and for the examination of certain named officers of the Corps of Engineers, with view to their promotion. Member of Board of Officers to determine upon a suitable locality for proving-ground, etc. In temporary charge of the improvement of the harbors of New York, Rondout, and Saugerties, N. Y. In temporary charge of the improvement of the Hudson and Harlem rivers and Sheepshead and Canarsie bays, N. Y.; Raritan Bay, N. J.; channel in Gowanus Bay and Buttermilk Channel; channel between Staten Island and New Jersey, and deepening Gedney's Channel, and Newtown Creek and Sumpawanus Inlet, N. Y. In temporary charge of the removal of obstructions in East River and Hell Gate, N. Y. In temporary charge of removal of wreck of

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Statement showing rank and duties of officers of Corps of Engineers — Cont'd.

RANK AND NAME.	DUTIES.
LIEUTENANT-COLONELS. (continued.)	
	sloop *Locomotive* in Hudson River; of wreck of bark *Quick-step* in Main Ship Channel, New York Harbor, and of wreck of canal-boat in Harlem River at High Bridge. In temporary charge of preliminary examination or survey of Spring Creek, N. Y. In temporary charge of survey of Hudson River between New Baltimore and Coxsackie, N. Y. To temporarily exercise supervision over construction of bridge across the East River between the city of New York and Long Island.
Charles R. Suter	Member of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member and President of the Missouri River Commission, created by act of Congress approved July 5, 1884. Member of Board of Engineer Officers to consider and report upon the construction of bridges across the Missouri River between its mouth and the mouth of Dakota or James River; across the Mississippi River between Saint Paul, Minn., and Natchez, Miss.; and across the Illinois River between its mouth and La Salle, Ill. To exercise supervision over the construction of bridges across the Missouri River at or near Sioux City, Iowa; opposite to or within the corporate limits of Nebraska City, Nebr., and between the cities of Omaha, Nebr., and Council Bluffs, Iowa. Engineer 15th and 16th Light-house districts.
Jared A. Smith	In charge of Forts Knox, Popham, Gorges, Scammel, McClary, and batteries at Portland Head and Gerrish's Island, Me., and Fort Constitution and battery at Jerry's Point, N. H., and of construction of Fort Preble, Me. In charge of the improvement of the harbors at Bangor, Belfast, Rockland, Portland, and York, Me., and Portsmouth, N. H., and harbor of refuge at Little Harbor, N. H. In charge of the improvement of the rivers Penobscot, Kennebunk, Saco, and Narraganugus, Me., and Cocheco, N. H.; Saco River Breakwater, Lubec Channel, Moose-a-bec Bar, and channel in Back Cove, Portland, Me. In charge of preliminary examinations of Big Rapids of St. John's River; St. George's River from Warren to Thomaston, and Matinicus Isle with view to harbor of refuge, Me. In charge of preliminary examinations and surveys of Bagaduce River between Penobscot and Brooksville; Camden and Rockport harbors; Kennebec River at Bath, and from Augusta to lower end of Perkin's Island; Penobscot River from Bangor to Bucksport Narrows; St. Croix River from Ferry Point Bridge at Calais to Breakwater Ledge, and Bar Harbor, with view to establishing breakwater, etc., Me., and Bellamy River, N. H. In charge of surveys of Bagaduce River between Penobscot and Brooksville; Camden and Rockport harbors; Kennebec River at Bath, and from Augusta to lower end of Perkin's Island; Penobscot River from Bangor to Bucksport Narrows, Me.
MAJORS.	
Samuel M. Mansfield .... *Bvt. Lieut. Colonel.*	In charge of the improvement of the harbors at Charlevoix, Frankfort, Manistee, Ludington, Pentwater, White River, Muskegon, Grand Haven, Black Lake, Saugatuck, South Haven, and Saint Joseph, and harbor of refuge at Portage Lake, Mich., and harbor at Michigan City, Ind. Engineer 9th, 10th, and 11th Light-house districts.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
William R. King	Member of The Board of Engineers. Commanding Post and Engineer School of Application at Willets Point, N. Y., and the Battalion of Engineers. In charge of the construction of Fort Schuyler; of fort and engineer depot at Willets Point, N. Y.; torpedoes for harbor defense, and of experiments with torpedoes. In charge of the construction of officers' quarters, mess, etc., at Willets Point, N. Y., and of disbursements for same. In charge of funds pertaining to the Library of the Engineer School of Application. Member of Boards of Engineer Officers on plan and estimate for a lock at or near the Lower Island at Nashville, for improving Cumberland River, Tenn.; on construction of bridges across Staten Island Sound (known as Arthur Kill) and the Kill Von Kull; to report upon the "Auto-Mobile Controllable Torpedo" of Mr. J. N. H. Patrick, and for the examination of certain named officers of the Corps of Engineers, with view to their promotion. Member of General Courts-martial convened at Willets Point, N. Y., January 23 and February 24, 1888. On temporary detached service at Newport, R. I.
Wm. H. H. Benyaurd	In charge of the improvement of the harbor at San Diego, and construction of breakwater at Wilmington Harbor, Cal. In charge of examinations and surveys for channel in San Diego Harbor, and at Newport Harbor; establishment of breakwater at San Luis Obispo Harbor, and of San Pedro Bay near entrance to Wilmington Harbor, Cal. To examine into the condition of the navigable channel of San Diego Bay, and the wharfage frontage thereon, etc.
Garret J. Lydecker	In charge of the Washington Aqueduct; increasing water supply of the city of Washington, and the erection of fish-ways at Great Falls of the Potomac River. Member of Board of Engineer Officers in connection with the Bennington Battle Monument.
Amos Stickney	In charge of the Louisville and Portland Canal. In charge of the improvement of the Falls of the Ohio River, Wabash River, Ind. and Ill., and White River, Ind. In temporary charge of the improvement of the Kentucky and Tradewater rivers; of preliminary examination of Pond River, and of preliminary examinations and surveys of Licking River from Farmers to West Liberty, and Salt River, Ky. To exercise supervision over the construction of the proposed road of the Carrollton or Lock No. 1 Turnpike Co. through the land of the United States at Lock No. 1, Kentucky River, and of bridge across the Tradewater River, Ky. Member of Boards of Engineer Officers to consider and report upon new plans for the proposed bridge across the Ohio River near Pittsburgh, Pa.; to consider and prepare general regulations concerning the erection of bridges over the Muskingum River, Ohio; to examine and report upon plan and location of proposed bridge across the Ohio River between Cincinnati, Ohio, and Newport, Ky.; and to examine and report upon the plans of the proposed bridge across the Ohio River at Louisville, Ky.
Alexander Mackenzie	In charge of the improvement of the Mississippi River from Saint Paul to Des Moines Rapids; the Upper Mississippi River, and Rock Island Rapids and Des Moines Rapids of the Mississippi River, and of removing bar in Mississippi River opposite Dubuque, Iowa. In charge of the construction of a dry-dock at the Des Moines Rapids Canal;

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	of ice-harbor at Dubuque, Iowa and of harbors of refuge on Lake Pepin at Stockholm, Wis., and Lake City, Minn. In charge of operating the Des Moines Rapids Canal and of operating snag-boat on Upper Mississippi River. In charge of the work in connection with the Adams Flume, Mississippi River. To supervise the work of alteration in the ponton bridge across the Mississippi River at Prairie du Chien, Wis. Member of Boards of Engineer Officers to consider and report upon location and plans of bridge across the Mississippi River at Dubuque, Iowa; to consider and report upon the improvement of the Mississippi River from Des Moines Rapids to the mouth of the Illinois River; to consider and report upon the construction of bridges across the Missouri River between its mouth and the mouth of the Dakota or James River; across the Mississippi River, between Saint Paul, Minn., and Natchez, Miss., and across the Illinois River between its mouth and La Salle, Ill.; to examine and report upon plan and location of proposed bridge across the Ohio River between Cincinnati, Ohio, and Newport, Ky., and to consider and recommend a plan for the improvement of the navigation at the mouth of the Cumberland River. Member of the Missouri River Commission created by act of Congress approved July 5, 1884.
Oswald H. Ernst	In charge of the improvement of the harbors at Galveston and Brazos Santiago, Tex. In charge of the improvement of ship channel in Galveston Bay, Pass Cavallo, Aransas Pass and Bay up to Rockport and Corpus Christi, mouth of Brazos River, Buffalo Bayou; deepening channel at mouth of Trinity River, and removal of obstructions to Liberty, Tex. In charge of preliminary examination of Cedar Bayou, Galveston Bay, Tex. Member of Board of Engineer Officers on proposed bridge across the Mississippi River at Memphis, Tenn. Member of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member of the Missouri River Commission created by act of Congress approved July 5, 1884.
David P. Heap	Detached; Engineer secretary to the Light-House Board. Engineer 3d and 4th Light-house districts.
William Ludlow ..... *Bvt. Lieut. Colonel.*	Detached; Engineer Commissioner of the District of Columbia. Engineer 4th Light-house District.
William A. Jones.....	In charge of the improvement of the Upper and Lower Columbia and Snake Rivers, Oregon and Wash.; Willamette River above Portland, and Lower Willamette River below Portland, Oregon; Cowlitz River, Wash.; Yamhill River, Oregon, and Lower Clearwater River, Idaho. On leave of absence.
Andrew N. Damrell.....	In charge of Forts Morgan and Gaines, Ala., and fort on Ship Island, Miss. In charge of the improvement of the harbor at Mobile, Ala. In charge of the improvement of the rivers Warrior and Black Warrior, Ala.; Pascagoula, Pearl, and Noxubee, Miss.; Tombigbee, Ala. and Miss.; the roadstead leading into Back Bay of Biloxi in Mississippi Sound; channel of Biloxi Bay, and Old Town Creek and Horn Island Pass, Miss. In charge of preliminary examination of Noxubee River, Miss. In charge of preliminary examination and survey of Tombigbee River from Vienna, Ala., to Walker's Bridge, Miss. In charge of survey of Tombigbee River from Vienna, Ala., to Walker's Bridge, Miss. To exercise supervision over the construction of bridge across Tombigbee River, at Waverly, Miss.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
Charles J. Allen.....	In charge of the improvement of the Chippewa River, and protection of Yellow Banks on the same; of the Minnesota and St. Croix rivers, and the Red River of the North; of the Mississippi River above the Falls of St. Anthony; of the Falls of St. Anthony; construction of Meeker's Island lock and dam, and lock and dam at Goose Rapids, on Red River of the North. In charge of the improvement of the Yellowstone River, Mont. and Dak., and the Missouri River from Sioux City, Iowa, to Fort Benton, Mont. In charge of construction and improvement of roads and bridges in Yellowstone National Park. In charge of the construction of reservoirs at headwaters of the Mississippi River and its tributaries. In charge of examination and surveys of the sources of the Mississippi, St. Croix, Chippewa, and Wisconsin rivers, with the view to ascertaining the practicability and cost of creating and maintaining reservoirs, etc. In charge of preliminary examinations of Red Lake River from Grand Forks to Red Lake, Minn., and harbor at Hudson, Lake St. Croix, Wis., and examination and report on causes of the extraordinary overflows of the Chippewa River, Wis., and the means to be adopted to prevent their recurrence. In charge of preliminary examinations and surveys of Red River of the North from Moorehead to Fergus Falls; Mississippi River between Saint Paul and St. Anthony's Falls, and Minnesota River with view to its improvement by locks and dams, Minn. In charge of surveys of Mississippi River between Saint Paul and St. Anthony's Falls, and Minnesota River with view to its improvement by locks and dams, Minn. To exercise supervision over construction of bridge across Red River of the North at Grand Forks, Dak. Member of Board of Engineer Officers to investigate and report upon all matters concerning the work in progress in connection with the "practical test of the flume invented by M. J. Adams," etc.
Charles W. Raymond...	In charge of the First and Second Divisions, Office of the Chief of Engineers. Detached; Engineer Commissioner of the District of Columbia.
L. Cooper Overman.....	In charge of the improvement of harbors at Monroe, Mich., Toledo, Port Clinton, Sandusky, Vermillion, Huron, Black River, Rocky River, Cleveland, Fairport, Ashtabula, and Conneaut, Ohio. In charge of improvement of Sandusky River, Ohio. In charge of water-level observations on Lake Erie. In charge of preliminary examination of Chagrin River at its mouth, Ohio. In charge of removal of wreck of schooner *Joy* from Ashtabula Harbor, Ohio. Engineer 10th Light-house District.
Alexander M. Miller	In charge of the improvement of the rivers Mississippi and Missouri—removal of snags, etc., Mississippi River between the mouths of the Illinois and Ohio rivers; Osage River, Mo., and Kans., and Gasconade River, Mo. In charge of resurvey of the Osage River from mouth to Osceola, with view to movable locks and dams, etc. In charge of preliminary examinations and surveys of Kaskaskia River from New Athens to mouth, and of Mississippi River at Rush Island Bend and Ivy Landing, Ill. In charge of surveys of Kaskaskia River from New Athens to mouth, and of Mississippi River at Rush Island Bend and Ivy Landing, Ill. Member of Boards of Engineer Officers to consider and report upon location and plans of

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	bridge across the Mississippi River at Dubuque, Iowa; to consider and report upon the improvement of the Mississippi River from Des Moines Rapids to the mouth of the Illinois River; and to consider and report upon the construction of bridges across the Missouri River between its mouth and the mouth of Dakota or James River; across the Mississippi River between Saint Paul, Minn., and Natchez, Miss,; and across the Illinois River between its mouth and La Salle, Ill.
Milton B. Adams	In charge of Fort Montgomery, N. Y. In charge of the improvement of the harbors at Ogdensburgh, on the river St. Lawrence, and Plattsburgh, Burlington, and Swanton, and construction of breakwaters at Rouse's Point and Gordon's Landing, on Lake Champlain. In charge of the improvement of Ticonderoga and Grass rivers, and of narrows at Lake Champlain, N. Y., and Otter Creek, Vt. In charge of preliminary examinations of Spring Creek and Waddington Harbor, N. Y.
William R. Livermore ..	In temporary charge of the forts at Clark's Point, Mass., at Dutch Island, R. I., and of the construction of Fort Adams, R. I. In temporary charge of the construction of harbor of refuge at Wood's Holl, Mass. In temporary charge of the improvement of the harbors at Nantuckett, Wood's Holl, Westport, Wareham, and Hyannis, Mass., Newport and Block Island, R. I., and Stonington, Conn. In temporary charge of the improvement of the rivers Taunton, Mass., Pawtucket, Providence, Warren, and Pawcatuck, and Narragansett Bay, R. I. and Little Narraganset Bay, R. I. and Conn., and removal of Green Jacket Shoal, Providence River, R. I. In temporary charge of preliminary examinations of Falmouth and Menemsha harbors of refuge, and Cottage City Harbor, Mass., and Little Narragansett Bay, entrance to the wharfs at Watch Hill, R. I. In temporary charge of preliminary examinations and surveys of Vineyard Haven and New Bedford harbors, and Taunton River, Mass. In temporary charge of survey of Taunton River, Mass. Temporarily a member of advisory counsel to the Rhode Island State board of harbor commissioners.
William H. Heuer	In charge of Forts Jefferson and Taylor, Fla., and Jackson, St. Philip, Livingston, Pike, and Macomb, Tower Dupré, Battery Bienvenue, and Tower at Proctorsville, La., In charge of the improvement of Humboldt Harbor and Bay, Cal. In charge of the improvement of the Sacramento, Feather, San Joaquin, and Mokelumne rivers, and Petaluma Creek, Cal. In charge of the improvement of the Amite, Tangipahoa, Tickfaw, Tchefuncte, Bogue Falia, and Calcasieu rivers, Bayous Terrebonne, Teche, Black, and Courtableau, and Calcasieu Pass, La., Bayou Pierre, Miss., Sabine Pass, Blue Buck Bar, and Neches River, Tex., and Sabine River, La. and Tex., and of removal of obstructions in Bayou La Fourche, La. In charge of connecting Bayou Teche with Grand Lake at Charenton, La. In charge of preliminary examinations of Bayou Rouge, Bogue Falia from present landing to Covington, bar obstructing mouth of Calcasieu River, Bayou Terrebonne from Houma to Thibodeaux, and Bayou Teche from St. Martinsville to Fort Barre, mouth of Bayou La Fourch, with view to construction of a lock and dam, Bayou La

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
MAJORS. (continued.)	
	Fourche to secure navigation at low water, and Bayou Vermillion to secure navigation from Abbeville to the Louisiana and Texas Railroad Bridge, La. In charge of preliminary examinations and surveys of mouth of Bayou Plaquemine, Bayou Plaquemine and other connecting streams, and Calcasieu Pass, La. To report upon the depth and width of a channel secured and maintained by jetties constructed by James B. Eads at the mouth of the Mississippi River. Member of Board of Engineer Officers on subject of permanent improvement of Delaware River and Bay. Engineer 7th, 8th, and 12th Light-house districts.
William S. Stanton.....	Detached; Engineer 1st and 2d Light-house districts.
Thomas H. Handbury...	In charge of Fort Stevens, Oregon, and of the construction of Fort Canby, Wash. In charge of improvement of the harbors at Chicago and Calumet, Ill. In charge of the improvement of the Illinois and Calumet rivers. In charge of the improvement of the Columbia River at Cascades, Oregon, mouth of the Columbia River, Oregon and Wash.; of the rivers Chehalis, Skagit, Stielaquamish, Nootsack, Snohomish, and Snoqualmie, Wash. In charge of water-gauges on the Columbia River from Astoria to the bar. In charge of survey of the Hennepin Canal. In charge of preliminary examination of Calumet River from forks of the river near its entrance into Lake Calumet to Blue Island, and of Farm Creek, with view to changing its course, Ill. Member of Board of Engineer Officers to consider and report upon the construction of bridges across the Missouri River between its mouth and the mouth of Dakota or James River; across the Mississippi River between Saint Paul, Minn., and Natches, Miss.; and across the Illinois River between its mouth and La Salle, Ill. Engineer Officer, Division of the Missouri. Engineer 13th Light-house District.
James C. Post	In charge of the Third Division, Office of the Chief of Engineers. Member of Board of Engineer Officers on construction of the locks at the Cascades, Columbia River, Oregon.
James F. Gregory	Detached; Engineer 5th and 6th Light-house districts. Engineer Secretary of the Light-house Board.
Henry M. Adams	On duty in Office of the Chief of Engineers. On duty under the direction of the Secretary of War. Member of Board of Engineer Officers to investigate and report upon all matters concerning the work in progress in connection with the "practical test of the flume invented by M. J. Adams," etc.
Charles E. L. B. Davis ..	In charge of the improvement of the harbors at Ashland, Wis., Ontonagon, Eagle Harbor, Marquette, Manistique, and Cedar River, Mich., Menomonee, Oconto, Pensaukee, Green Bay, Ahnepee, Kewaunee, Two Rivers, Manitowoc, Sheboygan, and Port Washington, Wis. In charge of harbors of refuge at entrance to Sturgeon Bay Canal, Lake Michigan, and Grand Marais, Mich. In charge of water-level observations on Lake Superior. In charge of the establishment and maintenance of harbor lines in Portage Lake, Mich. In charge of preliminary examination of Torch Lake Channel, Lake Superior, Mich.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS.	
George M. Wheeler.....	On temporary duty to supervise certain publications pertaining to geograpical surveys west of the 100th meridian. Retired from active service on June 15, 1888, in conformity with section 1251 Revised Statutes.
James B. Quinn	In charge of the improvement of the harbors of Duluth, Grand Marais, Agate Bay, Minn., and Superior Bay, on Lake Superior, and St. Louis Bay, Wis. To exercise supervision over construction of bridge across the St. Louis River between the States of Minnesota and Wisconsin.
Daniel W. Lockwood...	In charge of the improvement of the harbors at Charlevoix, Frankfort, Manistee, Ludington, Pentwater, White River, Muskegon, Grand Haven, Black Lake, Saugatuck, South Haven, and Saint Joseph, and harbor of refuge at Portage Lake, Mich., and harbor at Michigan City, Ind. In charge of the improvement of Little Kanawha, Guyandotte, and Buckhannon rivers, W. Va.; Big Sandy River, W. Va. and Ky., and Kentucky River, Ky. In charge of preliminary examination of Grand River, Mich. In charge of preliminary examinations and surveys of Pigeon River; Carp River at Leland, for harbor of refuge; Lake Michigan at Empire, and Grand Traverse Bay, Mich. To exercise supervision over the construction of the proposed road of the Carrollton or Lock No. 1, Turnpike Company, through the land of the United States at Lock No. 1, Kentucky River, Ky. Member of Board of Engineer Officers on proposed bridge across the Ohio River at Louisville, Ky.
Ernest H. Ruffner.....	In charge of the improvement of the Mississippi River between Des Moines Rapids and the mouth of the Illinois River. In charge of preliminary examination and survey of bars in Hamburg Bay, Ill.
John C. Mallery.....	Detached; engineer 4th, 5th, and 6th Light-House districts.
Clinton B. Sears.....	In charge of the improvement of the Yellowstone River, Mont. and Dak.; and the Missouri River from Sioux City, Iowa, to Fort Benton, Mont. In charge of preliminary examination of James River, Dak. In charge of construction and improvement of roads and bridges in Yellowstone National Park; in charge of the 1st and 2d Divisions, Office of the Chief of Engineers.
Thomas Turtle.....	In charge of the 4th and 5th Divisions, Office of the Chief of Engineers.
Edward Maguire	Commanding Company B, Battalion of Engineers. Instructor of Military Engineering at the Engineer School of Application. Secretary of Board of Officers and Civilians to examine and report at what ports fortifications, or other defenses are most urgently required, etc. Member of Boards of Engineer Officers on construction of bridges across Staten Island Sound (known as Arthur Kill), and the Kill Von Kull, and to report upon the "Auto-Mobile Controllable Torpedo," of Mr. J. N. H. Patrick. Member of General Courts-martial convened at Willets Point, N. Y., August 5; November 3, 1887; February 24 and March 29, 1888.
Frederick A. Mahan	In charge of the improvement of the harbors at Erie, Pa., and Buffalo, Wilson, Olcott, Oak Orchard, and Dunkirk, N. Y. In charge of improvement of Niagara River, N. Y. In charge of preliminary examinations and surveys of Tonawanda Harbor and Niagara River between Black Rock and Tonawanda, N. Y. In charge of survey of the peninsula and harbor at Erie, Pa.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
Charles F. Powell	In charge of Fort Stevens, Oregon, and of the construction of Fort Canby, Wash. In charge of the improvement of the Columbia River at Cascades, Oregon, mouth of the Columbia River, Oregon and Wash., entrance to Coos Bay, and entrance to Yaquina Bay, and mouth of Coquille River, Oregon. In charge of the improvement of the Umpqua River, Oregon, and of the rivers Chehalis, Skagit, Stielaquamish, Nootsack, Snohomish, and Snoqualmie, Wash. In charge of water-gauges on the Columbia River, from Astoria to the bar. In charge of preliminary examinations of Nehalem Bay and Bar, Wood and Link rivers, and Suislaw River and Bar, Oregon. In charge of preliminary examinations and surveys of Tillamook Bay and Bar, and Umpqua and Coquille rivers, Oregon. In charge of survey of Tillamook Bay and Bar, Oregon. Engineer 13th Light-house District. Detached; Secretary and Disbursing Officer of the Mississippi River Commission created by act of Congress approved June 28, 1879. Secretary and assistant to the Construction Committee of the Mississippi River Commission and Disbursing Officer for works carried on by the Commission.
Frederick A. Hinman...	In charge of the improvement of the harbor at Norfolk, and the approach to Norfolk Harbor and the United States Navy-yard, Va. In charge of the improvement of the Blackwater, Nottoway, Archer's Hope, and Appomattox rivers, Va., and Meherrin River, Currituck Sound, Coanjok and Edenton bays, and North River Bar, N. C., and North Landing River, Va. and N. C. In charge of preliminary examination of Alligator River, N. C. In charge of preliminary examination and survey of Nansemond River, Va. On sick leave of absence.
Albert H. Payson.....	In charge of the improvement of Humboldt Harbor and Bay, Cal. In charge of the improvement of the Sacramento, Feather, San Joaquin, and Mokelumne rivers, and Petaluma Creek, Cal., and Colorado River, Nev., Cal., and Ariz. In charge of preliminary examinations of mouth of Smith's River, and Crescent City Harbor with view to a sea-wall from Battery Point to Flat Rock, Cal. Engineer 12th Light-house District. Resignation accepted by the President, to take effect December 1, 1887.
John G. D. Knight	Commanding Company A, Battalion of Engineers. In charge of the construction of Fort Schuyler, N. Y. H. Detached; Instructor of Engineering at the United States Infantry and Cavalry School. On temporary detached service with New York State National Guard near Peekskill, N. Y. Member of General Court-martial convened at Willets Point, N. Y., November 3, 1887.
Richard L. Hoxie	In charge of Forts Pickens and McRee, and the construction of Fort Barrancas and redoubt, Fla. In charge of the improvement of Pensacola Harbor, Fla. In charge of the improvement of the rivers Coosa and Chattahoochee, Ga. and Ala., Ocmulgee, Oconee, Oostenaula, Coosawattee, and Flint, Ga., Choctawhatchee, Escambia, and Conecuh, Fla. and Ala., Alabama, Cahawba, and Tallapoosa, Ala., Apalachicola River and Bay, and La Grange Bayou, Fla. In charge of resurvey of outer and inner bars at Pensacola, Fla., and of examination and survey of Flint River from Montezuma to Old Agency, Ga. In charge of removal of wrecks of ship *Bride of Lorne* and bark *Laigia* in Pensacola Harbor, Fla.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
William L. Marshall....	In charge of the improvement of the harbors at Milwaukee, Racine, and Kenosha, Wis., Waukegan, Chicago, and Calumet, Ill., and harbor of refuge at Milwaukee Bay, Wis. In charge of the improvement of the Fox, Wisconsin, Illinois, and Calumet rivers. In charge of water-level observations on Lake Michigan. In charge of survey of the Hennepin Canal. Engineer Officer, Division of the Missouri. Member of Board of Engineer Officers to investigate and report upon all matters concerning the work in progress in connection with the "practical test of the flume invented by M. J. Adams," etc.
Joseph H. Willard.....	In charge of the improvement of Tensas River and Bayou Macon, and Cane River, La., Ouachita and Black River, and Bayou Bartholomew in La. and Ark. Bayous Bœuf and D'Arbonne, Loggy Bayou, Lake Bisteneau, and the Dorcheat, La. and Cypress Bayou, La. and Tex.; Red River, La. and Ark., and South Forked Deer River, Tenn.; of the rivers Big Sun Flower, Yazoo, Yallabusha, Big Black, and Tallahatchie, and Tchula Lake, and Steel's Bayou, Miss., and the Big Hatchie River, Tenn. In charge of survey of Bayou Pierre, La. In charge of the water-gauges on the Lower Mississippi River and its principal tributaries. In charge of preliminary examinations of the lakes connecting with Red River between Shreveport, La., and Fulton, Ark., Little, Dugdemona, and Cornay rivers, Ouachita River from Camden to mouth, Black, Red, Kelley, Cypress, Rondeway, and Vidal bayous, Clear and Black lakes, La., and Cassity Bayou, Miss., North Fork of the Forked Deer River, Tenn., and re-examination of Ouachita above Camden, Ark. To supervise the construction of the bridge across Yazoo River, near Greenwood, Miss., and across Sunflower River, near Johnsonville, Miss.
Philip M. Price.....	Detached; on duty at the Military Academy as Instructor of Practical Military Engineering, and in command of Company E, Battalion of Engineers. In charge of water-works and supply line, and Acting Signal Officer at West Point, N. Y. To inspect the work upon the monument at Washington's Headquarters, Newburgh, N. Y.
Carl F. Palfrey	In charge of the construction of Forts Porter, Niagara, and Ontario, N. Y. In charge of the improvement of the harbors at Charlotte, Pultneyville, Great Sodus, Little Sodus, Oswego, and Sacketts Harbor, N. Y. In charge of water-level observations on Lake Ontario.
William H. Bixby.....	In charge of Forts Macon and Caswell, N. C. In charge of the improvement of Beaufort Harbor, N. C. and Georgetown Harbor, S. C. In charge of the improvement of Cape Fear River above and below Wilmington, Neuse, Pamlico, Tar, Yadkin, Black, Trent, and New rivers, and Contentnia or Moccasin River and inland water-way from New Berne to Beaufort, and inland water-way between Beaufort Harbor and New River, N. C., and Santee, Wateree, Great Pee Dee, Waccamaw and Congaree rivers, and Winyaw Bay, S. C. In charge of preliminary examinations of Catawba River, and Yadkin River from South Carolina line to the Narrows, N. C. In charge of preliminary examinations and surveys of the rivers Lumber and Lockwood's Folly, N. C., and Little Pee Dee, and Alligator and other waters connecting Santee River and Bull's Bay, S. C., and Mingo and Clark's creeks, S. C.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
Henry S. Taber	In charge of the improvement of the Arkansas River—removal of snags, etc.; Arkansas River at Pine Bluff, and of rivers White and St. Francis, L'Anguille, and Saline, Red above Fulton, Little Red and Petit Jean, Ark., Black, Mo. and Ark., and of removal of rock shoals in Fourche River, Ark. In charge of survey of Arkansas River from Little Rock to its mouth. In charge of preliminary examination of Saline River, and re-examination of Little River, Ark. In charge of preliminary examinations and surveys of Cache River, Ark., Little River from Hornersville to its junction with the St. Francis River, and St. Francis River from Greenville to the Arkansas State line, Mo., and examination of Red River at railroad bridge, Fulton, Ark.
Eric Bergland	Commanding Company C, Battalion of Engineers. Instructor in civil engineering at the Engineer School of Application. Member of General Courts-Martial convened at Willets Point, N. Y., August 5, 1887, and January 23, 1888. On leave of absence.
William T. Rossell	In charge of 3d District of the Mississippi River, from mouth of White River to Warrenton, for the purpose of improvement and the construction and repair of levees, to include the improvement of the harbor at Vicksburg, Miss. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. In temporary charge of First District of the Mississippi River, from Cairo to foot of Island No. 40, and of 2d District from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees.
Thomas W. Symons	Detached; assistant to the Engineer Commissioner of the District of Columbia.
Smith S. Leach	In charge of 1st District of the Mississippi River from Cairo to foot of Island No. 40, and of 2d District from foot of Island No. 40 to mouth of White River, for the purpose of improvement and the construction and repair of levees. Secretary and Disbursing Officer of the Mississippi River Commission created by act of Congress approved June 28, 1879. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River. Detached; assistant to the Engineer Commissioner of the District of Columbia.
Dan C. Kingman	In charge of 4th District of the Mississippi River, from Warrenton to Head of the Passes, for the purpose of improvement and the construction and repair of levees, to include levees and special work on the river, the improvement of the harbor at New Orleans, the Mississippi River at Natchez and Vidalia, the mouth of Red River, and the rectification of the Red and Atchafalaya rivers at mouth of Red River. Member of Board of Engineer Officers on proposed bridge across the Mississippi River at Memphis, Tenn. Member of Board of Engineer Officers on building and repair of levees on the Mississippi River.
Eugene Griffin	Detached; assistant to the Engineer Commissioner of the District of Columbia. On temporary duty in office of the Chief of Engineers. On leave of absence.
Willard Young	In charge of the improvement of Umpqua River, mouth of Coquille River, and entrances to Coos and Yaquina bays, Oregon. In charge of preliminary examinations and surveys of Umpqua and Coquille rivers, Oregon. In tempor-

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
	ary charge of the improvement of the Upper and Lower Columbia and Snake rivers, Oregon and Wash., Willamette River above Portland, and Lower Willamette River below Portland, Oreg., Cowlitz River, Wash., Yamhill River, Oregon, and Lower Clearwater River, Idaho.
William M. Black.....	In charge of the construction of Fort Marion, Fla. In charge of the improvement of the harbors at Key West, Tampa Bay, and Cedar Keys, Fla. In charge of the improvement of the Saint John's River (at channel over bar at mouth, and Upper Saint John's River), Volusia Bar, Caloosahatchee, Manatee, Withlacoochee, and Suwanee rivers, and Pease Creek, Fla. In charge of examination and survey of entrance to harbor at Key West, Fla. In charge of resurvey of Tampa Bay, including Hillsborough River up to Tampa, and of preliminary examinations of Charlotte Harbor, including San Carlos Bay, Clear Water Harbor, including Anclote and Saint Joseph's bays, and narrows into Boga Ciega Bay; Wakulla River, from mouth to Wakulla Springs; and of survey of channel from Haul-over on Indian River to Gilbert's Bar, Fla. In charge of preliminary examinations and surveys of Punta Rassa Harbor, and Saint Augustine for deep-sea channel on the outer bar, Fla. In charge of surveys of Punta Rassa Harbor, and Saint Augustine for deep-sea channel on the outer bar, Fla. In charge of removal of wrecks of *Transport*, *Maple Leaf*, and German brig from Saint John's River, between its mouth and Lake George.
Walter L. Fisk.....	Detached; on duty at the Military Academy as Assistant Professor of Civil and Military Engineering. On temporary duty in the office of the Chief of Engineers. In charge of Forts Jefferson and Taylor, Fla., and Jackson, St. Philip, Livingston, Pike, and Macomb, Tower Dupré, Battery Bienvenue, and Tower at Proctorsville, La. In charge of the improvement of the Amite, Tangipahoa, Tickfaw, Tchefuncte, Bogue Falia, and Calcasieu rivers, bayous Terrebonne, Teche, Black and Courtableau, and Calcasieu Pass, La.; Bayou Pierre, Miss.; Sabine Pass, Blue Buck Bar, and Neches River, Tex.; and Sabine River, La. and Tex., and of removal of obstructions in bayou La Fourche, La. In charge of connecting Bayou Teche with Grand Lake at Charenton, La. To report upon the depth and width of a channel secured and maintained by jetties constructed by James B. Eads at the mouth of the Mississippi River. Engineer 7th and 8th Light-house districts.
Solomon W. Roessler...	Adjutant and Treasurer of the Battalion of Engineers and Post of Willets Point, and Signal Officer and Recruiting Officer, Post of Willets Point. Commanding Companies A and D, Battalion of Engineers. Inspector of Rifle Practice, Battalion of Engineers. In charge of the library of the Engineer School of Application. Acting Battalion Q. M., A. A. Q. M., and A. C. S., Post of Willets Point. Instructor in Submarine Mining at the Engineer School of Application. Member of Board of Engineer Officers to report upon the "Auto-Mobile Controllable Torpedo" of Mr. J. N. H. Patrick. Member of General Courts-Martial convened at Willets Point, N. Y., January 23 and March 29, 1888.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
CAPTAINS. (continued.)	
George McC. Derby	In charge of the improvement of Keyport Harbor. In charge of the improvement of the rivers Shewsbury, Rahway, Elizabeth, Manasquan, South, Raritan, and Passaic above and below Newark, and Woodbridge, Cheesequakes, and Mattawan creeks, N. J. On duty under the immediate orders of Lieutenant-Colonel McFarland.
FIRST LIEUTENANTS.	
James L. Lusk.....	Detached; Secretary and Disbursing Officer of the Mississippi River Commission created by act of Congress approved June 28, 1879. Secretary and assistant to the Construction Committee of the Mississippi River Commission and Disbursing Officer for works carried on by the Commission. Detached; assistant to the Engineer Commissioner of the District of Columbia.
Frederic V. Abbot	On duty under the immediate orders of Colonel Gillmore. On duty under the immediate orders of Colonel Abbot. In charge of Forts Moultrie, Sumter, and Johnson, and of the construction of Castle Pinckney, S. C. In charge of the improvement of the harbor at Charleston, S. C. In charge of the improvement of the Ashley, Edisto, and Salkiehatchie rivers and Wappoo Cut, S. C. In charge of preliminary examination of North Fork of the Edisto River, S. C. In charge of removal of wreck of trading boat in Cheehaw River, and of wreck of steamer *Alice Clark* from the channel of inside passage below Charleston, S. C.
Thomas L. Casey	Detached; Engineer Officer Division of the Pacific and Department of California. On duty under the immediate orders of Major Livermore.
Theodore A. Bingham .	Detached; Secretary and Disbursing Officer of the Missouri River Commission, created by act of Congress approved July 5, 1884. Recorder of Board of Engineer Officers to consider and report upon the construction of bridges across the Missouri River between its mouth and the mouth of Dakota or James River; across the Mississippi River between St. Paul, Minn., and Natchez, Miss., and across the Illinois River between its mouth and La Salle, Ill.
Curtis McD. Townsend.	On duty under the immediate orders of Major Lydecker. Recorder of Board of Engineer Officers on construction of locks at the Cascades, Columbia River, Oreg.
Gustav J. Fiebeger	Detached; on duty at the Military Academy as Assistant Professor of Civil and Military Engineering. Member of General Court-martial convened at West Point, N. Y., September 9, 1887.
Oberlin M. Carter	On duty under the immediate orders of Colonel Gillmore. On duty under the immediate orders of Colonel Abbot. In charge of Forts Oglethorpe and Pulaski, Ga., and Clinch, Fla. In charge of the improvement of the harbors at Savannah and Brunswick, Ga. In charge of the improvement of Cumberland Sound, Ga. and Fla., Savannah and Altamaha rivers, and Romerly Marsh, Ga.
George W. Goethals....	Detached; on duty at the Military Academy in Department of Civil and Military Engineering.
John Millis	Detached; on temporary duty as Engineer of the 3d Lighthouse District. On duty under the immediate orders of Major Heap.
John Biddle.....	Detached; Engineer Officer Department of Dakota. On duty as Assistant Instructor of Practical Military Engineering at the Military Academy, and with Company E, Battalion of Engineers. Recruiting Officer for Company E, Battalion of Engineers.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
Harry F. Hodges.....	On duty under the immediate orders of Lieutenant-Colonel Poe.
James G. Warren.....	Detached; on duty as Assistant Instructor of Practical Military Engineering at the Military Academy, and with Company E, Battalion of Engineers. Officer in charge of Post Schools, and Recruiting Officer for Company E, Battalion of Engineers. Adjutant and Treasurer of the Battalion of Engineers and Post of Willets Point, and Signal Officer and Recruiting Officer, Post of Willets Point. Commanding Company D, Battalion of Engineers. Inspector of Rifle Practice, Battalion of Engineers. In charge of property pertaining to the Library of the Engineer School of Application.
Edward Burr.....	On duty under the immediate orders of Captain Powell. On duty under the immediate orders of Major Handbury.
Oscar T. Crosby	On duty under the immediate orders of Major Heuer. On leave of absence. Resignation accepted by the President, to take effect October 22, 1887.
Lansing H. Beach.....	On duty under the immediate orders of Lieutenant-Colonel Merrill. Member and Disbursing Officer of Commission to run and mark the boundary lines between a portion of the Indian Territory and the State of Texas. Member of Board of Engineer Officers to consider and prepare general regulations concerning the erection of bridges over the Muskingum River, Ohio.
Graham D. Fitch.....	On duty under the immediate orders of Captain Marshall.
Eugene J. Spencer	On duty under the immediete orders of Major Stickney. Detached; on duty at the Military Academy in Department of Chemistry, Mineralogy, and Geology. Member of General Court-martial convened at West Point, N. Y., September 9, 1887.
George A. Zinn.....	On duty under the immediate orders of Major Ernst. On leave of absence.
William C. Langfitt	Detached; Engineer Officer Department of the Columbia. Member of General Court-martial convened at Vancouver Barracks, Wash., April 23, 1888.
Henry E. Waterman....	On duty under the immediate orders of Lieutenant-Colonel Barlow. Recorder of Boards of Engineer Officers upon plan an estimate for a lock at or near Lower Island at Nashville, for improving Cumberland River, Tenn.; and to consider and recommend a plan for the improvement of the navigation at the mouth of the Cumberland River.
Irving Hale.....	Quartermaster Battalion of Engineers. Acting Assistant Quartermaster and Acting Commissary of Subsistence, Post of Willets Point. Instructor in Military Photography at the Engineer School of Application. Member of Board of Engineer Officers to report upon the "Auto-Mobile Controllable Torpedo" of Mr. J. N. H. Patrick. Member of General Court-martial convened at Willets Point, N. Y., February 24, 1888.
James C. Sanford.....	On duty under the immediate orders of Lieutenant-Colonel Houston. In temporary charge of the improvement of Keyport Harbor. In temporary charge of the improvement of the rivers Shrewsbury, Rahway, Elizabeth, Manasquan, South, Raritan, and Passaic above and below Newark, and Woodbridge, Cheesequakes, and Mattawan creeks, N. J.
Hiram M. Chittenden...	On duty with Company B, Battalion of Engineers. Detached; Engineer Officer Department of the Platte.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
FIRST LIEUTENANTS. (continued.)	
Cassius E. Gillette.....	On duty under the immediate orders of Lieutenant-Colonel Merrill. Recorder of Boards of Engineer Officers to consider and prepare general regulations concerning the erection of bridges over the Muskingum River, Ohio, and on proposed bridge across the Mississippi River at Memphis, Tenn.
David DuB. Gaillard....	On duty under the immediate orders of Captain Black.
Harry Taylor.....	On duty under the immediate orders of Captain Bixby.
William L. Sibert.....	On duty with Company C, Battalion of Engineers. On duty under the immediate orders of Major Stickney. On duty under the immediate orders of Captain Lockwood. Recorder of Boards of Engineer Officers to examine and report upon plan and location of proposed bridge across the Ohio River between Cincinnati, Ohio, and Newport, Ky., and to examine and report upon the plans of the proposed bridge across the Ohio River at Louisville, Ky.
SECOND LIEUTENANTS.	
Joseph E. Kuhn	On duty with and in temporary command of Company B, Battallion of Engineers. Ordnance Officer Post of Willets Point. Under instruction at the Engineer School of Application. On duty under the immediate orders of Major Mansfield. Recorder of Board of Engineer Officers to consider and report upon location and plans of bridge across the Mississippi River at Dubuque, Iowa. Judge-Advocate of General Courts-martial convened at Willets Point, N. Y., August 5, 1887, and March 29, 1888. Member of General Court-martial convened at Willets Point, N. Y., January 23, 1888.
William E. Craighill....	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. On temporary detached service at Fort Niagara, N. Y. Recorder of Board of Engineer Officers to consider and report upon the improvement of the Mississippi River from Des Moines Rapids to the mouth of the Illinois River. Member of General Courts-martial convened at Willets Point, N. Y., August 5, November 3, 1887, and January 23, 1888. Judge-Advocate of General Court-martial convened at Willets Point, N. Y., February 24, 1888.
Henry C. Newcomer	On duty with and in temporary command of Company C, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., August 5, 1887; January 23, and March 29, 1888.
Mason M. Patrick	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., August 5, 1887; January 23, and March 29, 1888. Judge-Advocate of General Court-martial convened at Willets Point, N. Y., November 3, 1887.
Charles S. Riché.....	On duty with Company B, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., August 5 and November 3, 1887, and February 24, 1888. Judge-Advocate of General Court-martial convened at Willets Point, N. Y., March 29, 1888.
Thomas H. Rees.....	On duty with Company A, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., August 5, 1887, and March 29, 1888. Judge-Advocate of General Courts-martial convened at Willets Point, N. Y., January 23 and March 29, 1888.

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Statement showing rank and duties of officers of Corps of Engineers—Cont'd.

RANK AND NAME.	DUTIES.
SECOND LIEUTENANTS. (continued.)	
Charles L. Potter.....	On duty with Company C, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., August 5, November 3, 1887, and February 24, 1888.
Francis R. Shunk	On duty with Company B, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willets Point, N. Y., November 3, 1887; February 24 and March 29, 1888.
James J. Meyler.....	On duty with Company C, Battalion of Engineers. Under instruction at the Engineer School of Application. Member of General Courts-martial convened at Willetts Point, N. Y., November 3, 1887; February 24 and March 29, 1888.
Eugene W. Van C. Lucas.	To report to the Commanding Officer, Battalion of Engineers, for duty with the battalion.
U. S. AGENTS.	
S. T. Abert	In charge of the improvement of the harbor at Breton Bay, Leonardtown, and at entrance of Saint Jerome Creek, Md. In charge of the improvement of the rivers Rappahannock, Chickahominy, Mattaponi, Totusky, York, Pamunkey, and Staunton, Va., Roanoke and French Broad, N. C., and Dan, Va. and N. C.; of channel in Potomac River through flats in front of landing at Mount Vernon, and of Neabsco, Nomini, and Urbana creeks, Va. In charge of preliminary examinations of Mattox and Hunter's creeks, Va. In charge of preliminary examinations and surveys of Patuxent River from Benedict to Hill's Landing, Md., and Roanoke River from Clarkesville, Va., to Eaton Falls, N. C. In charge of survey of Patuxent River from Benedict to Hill's Landing, Md. In charge of removal of wreck of schooner *Spray* in Rappahannock River below Fredericksburg, and of the removal of three wrecks from Mattaponi River, Va.
William F. Smith	In charge of the improvement of the habor at Wilmington, and ice-harbor at New Castle, Del. In charge of the improvement of the Maurice River, N. J., Broadkiln, Indian, Nanticoke, and St. Jones rivers, Duck, Mispillion, and Broad creeks, Del., Susquehanna River above and below Havre de Grace; of the Chester, Wicomico, Choptank, and Pocomoke rivers, Corsica Creek, upper thoroughfare at Deil's Island, Md, and inland water-way from Chincoteague Bay, Va., to Delaware Bay at or near Lewes, Del. In charge of preliminary examinations and surveys of Duck Creek, Del.; Cambridge Harbor and Fairlee Creek, Md. In charge of removal of wreck of steamer in Broadkiln River, Del.
U. S. CIVIL ENGINEER.	
M. Meigs	On duty under the immediate orders of Major Mackenzie.

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APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

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APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

FORTIFICATIONS, ETC.

APPENDIX No. 1.

POST OF WILLETS POINT, NEW YORK—ENGINEER SCHOOL OF APPLICATION—BATTALION OF ENGINEERS—ENGINEER DEPOT.

ANNUAL REPORT OF MAJOR WILLIAM R. KING, CORPS OF ENGINEERS, OFFICER IN COMMAND, FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

UNITED STATES ENGINEER SCHOOL,
Post of Willets Point, N. Y., July 27, 1888.

GENERAL: I have the honor to submit the following annual report on the Post of Willets Point, N. Y., the United States Engineer School, the Battalion of Engineers, and the Engineer Depot.

POST OF WILLETS POINT.

At the close of the fiscal year the garrison consisted of 20 commissioned officers and 352 enlisted men (for roster and changes during the year see report of the battalion commander herewith), including the following general staff and artillery officers:

Maj. J. C. G. Happersett, surgeon, U. S. Army.
Capt. E. C. Carter, assistant surgeon, U. S. Army.
Capt. C. P. Miller, assistant quartermaster, U. S. Army.
First Lieut. John Pope, jr., First U. S. Artillery.
Second Lieut. Thomas Ridgway, Fifth U. S. Artillery.
Second Lieut. Charles F. Parker, Second U. S. Artillery.

Captain Miller was assigned to duty as post quartermaster in January, 1888, and relieved July 1, 1888.

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The three officers of artillery were assigned to duty at the post in November, 1887, for special instruction in the torpedo service, and relieved on the 1st of July, 1888.

The improvements referred to in my last annual report as having been begun by the Quartermaster's Department, have been completed as follows:

I. The introduction of an adequate water supply; this was arranged for by a contract with the village of Flushing, N. Y., which secured the laying of mains to the line of the reservation and the daily supply of 60,000 gallons of water, which was tested and found to be of excellent quality. The entire labor of laying the mains and service-pipes upon the reservation was done by the enlisted men of the garrison. Over 2 miles of pipe was laid; also two 6-inch water meters, eight 6-inch gates, two 4-inch gates, and fourteen fire-hydrants, at a total cost for labor and material of $7,037.73. (For full details see report of post quartermaster, forwarded February 8, 1888.)*

II. The introduction of an adequate system of sewerage. This, also, has been done entirely by soldier labor. Over 6,000 feet of sewer-pipe was thus laid.

III. The necessary plumbing for sanitary purposes in barracks and quarters done by contract at a cost of about $7,200. This includes bath-tubs, water-closets, etc., in fifteen buildings.

IV. The double set of quarters for officers and the new hospital building, both of which are now in use.

The quartermaster's department has also furnished the material for putting down a system of brick walks. The labor is being done by enlisted men. This is a very desirable improvement to the post, as it was difficult to keep some of the walks in a passable condition in wet weather.

I would again earnestly recommend the following additional improvements, which are greatly needed for the proper and economical administration of affairs at the post, viz:

I. The new barracks recommended in last two annual reports and by a special board of officers, and for which plans and specifications have been submitted, are much needed. The old barracks, built of a combination of old and new materials many years ago, require more and more repairs from year to year, and their location, which was determined by certain unfortunate limitations, can be greatly improved. They were built when the companies were about half their present size, and are now overcrowded, although the number of men is still below the limit provided by law.

The estimate for this purpose comes within the province of the Quartermaster's Department, and was submitted to Congress (House Ex. Doc. 277, Fiftieth Congress, first session).

II. As stated in last annual report, the quartermaster and commissary warehouses, coal-yard, etc., are located at the extreme end of the post, and as far as possible from the wharf on which all stores and supplies must be landed. The extra cost of hauling coal, every ton of which has to be hauled nearly a mile further than is necessary, would alone be a sufficient reason for changing the location. Plans, specifications, and estimates for a suitable building to be located near the quartermaster's wharf, prepared by the post quartermaster and acting commissary of subsistence, have been sent in, and are again respectfully recommended for favorable consideration.

* Omitted.

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III. "The reservation is bounded on the west by a salt marsh, with a sluggish lagoon in the middle, and at low tide there is nothing to prevent unauthorized persons from entering or leaving the post without passing the guard-house, especially at night or in case of heavy fogs, which often prevail. I believe it was a part of the original design for the land defense of this place to clean out and deepen this lagoon and extend a broad ditch as far as the main road leading past the guard-house. This could be done without any great expense if a small dredging-machine could be borrowed from some of the Government works in the vicinity when not needed for other purposes. This work, if done, would greatly improve the sanitary condition of the post, and would, at the same time, reclaim considerable land, which is greatly needed for post gardens and for a target-range. The present range is too low and can not be used for skirmish-firing."

This would also make a suitable harbor for laying up our boats in winter where they will be protected from ice and storms.

IV. The soldiers' laboratory destroyed by fire in November, 1886, should be rebuilt as soon as possible. A clause appropriating money for this purpose has been inserted in the bill making appropriations for the support of the Army for the fiscal year ending June 30, 1889. Should this become available, the work could begin at once.

V. A suitable building should be provided for the collection of engineering models referred to in last two annual reports. The present building is an old, leaky, frame structure erected during the war, and very inconveniently located. It is not worth repairing. A suitable fire-proof building can be built for about $8,000.

The sanitary condition of the post during the year has been quite satisfactory, and with the recent improvements in the sewerage and water supply, there should be little to complain of in the future.

Only four deaths occurred at the post during the year; two from accidental drowning, one (a civilian) from consumption, and one from acute bronchitis. One soldier belonging to the post died of sunstroke at Newton, L. I., while absent without leave.

ENGINEER SCHOOL OF APPLICATION.

The scope and object of the school have been fully set forth in previous reports and in the order establishing it on its present basis; the orders issued in pursuance of the latter arranging the details of the season's work are appended, marked A, B, and C.

During the past year a class of two engineer officers completed the full course of three years, and a class of three artillery officers completed the seven-months' course in torpedo instruction and were relieved July 1, 1888.

The following tabular statement shows the constitution of each class, the subjects in which they have received instruction, and their marks in each subject for the year, the maximum in all cases being 3. These marks are the mean of marks awarded at examinations held as follows: January 3, February 1, March 3, April 3, and May 3, 1888.

Third winter's class.	Civil engineering.	Military engineering.
Second Lieut. J. E. Kuhn, Engineers	2.80	2.80
Second Lieut. W. E. Craighill, Engineers	2.61	2.76

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Second winter's class.	Civil engineering.	Military engineering.	Military photography.
Second Lieut. H. C. Newcomer, Engineers	2.83	2.80	3.0
Second Lieut. M. M. Patrick, Engineers	2.76	2.70	3.0
Second Lieut. C. S. Riché, Engineers	2.20	2.40	2.8
Second Lieut. T. H. Rees, Engineers	2.73	2.75	2.9
Second Lieut. C. L. Potter, Engineers	2.65	2.50	3.0

First winter's class.	Torpedoes.	Essays.	Surveying.
First Lieut. John Pope, jr., First Artillery	2.66	3.0	.....
Second Lieut. Thomas Ridgway, Fifth Artillery	2.76	3.0	.....
Second Lieut. C. F. Parker, Second Artillery	2.85	3.0	.....
Second Lieut. C. L. Potter, Engineers	2.93	2.8	.....
Second Lieut. F. R. Shunk, Engineers	2.79	3.0	2.54
Second Lieut. J. J. Meyler, Engineers	2.75	2.8	2.67

I. The library of the school is under the immediate charge of the post adjutant, and has received many valuable additions during the year in the way of standard scientific works and periodicals.

The appropriation asked for to keep the library up to the proper standard during the next fiscal year is $500, which is respectfully recommended.

II. Under authority of the Chief of Engineers it has been arranged for the officers on duty here to visit several manufacturing establishments in and around New York for the purpose of inspecting machinery and witnessing such mechanical operations and processes as were thought to be of professional interest.

The Brooklyn Navy-Yard, Continental Iron Works, and the Ordnance Proving Grounds at Sandy Hook have already been visited, and it is proposed to visit other works as soon as arrangements can be made for the purpose.

III. As post and battalion orders have been accumulating here for the past twenty-three years, many having become obsolete or inoperative from frequent amendment, the post adjutant has, under my direction, compiled and consolidated into a single post order all that appear to be desirable for the proper regulation and administration of the post.

IV. Attention is again invited to the fact that a much larger number of artillery officers could be accommodated here, and the cost of instructing two or three times the number recently detailed for the torpedo course would be hardly appreciable.

If a sufficient number of artillery officers can not be spared, it is respectfully recommended that details be made from the cavalry and infantry of officers who take an interest in such matters, and preferably of those who desire the detail. It is thought that if an opportunity was offered them to express their preferences in this matter enough would signify their willingness to undertake the seven-months' course to enable the War Department to select a proper number from for the detail.

V. Although not a matter of very great importance, I would respectfully recommend that the official designation of this establishment be abbreviated to "United States Engineer School." This would be uniform with "Artillery School," "Cavalry School," etc., and would be much shorter than the present title, which reads "Engineer School of Application of the Army of the United States." The word "application" besides being unnecessary is not altogether appropriate, as there are several theoretical branches of study included in the course.

VI. It is thought that the comfort and convenience of enlisted men

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will be greatly improved by starting what is known as a post canteen for them, and the post council has been requested to formulate a plan for making the experiment. There will be no expense attached to it, as it can be accommodated in one of the old buildings not needed for any other purpose, and the proceeds of sales and other sources of revenue, which now go to the post trader and outside parties, ought to pay all expenses and leave quite a revenue for post and company funds, applicable to the soldiers' mess allowances.

BATTALION OF ENGINEERS.

The law provides for five companies of engineer troops, having an authorized strength of 752 enlisted men, officered by details from the Corps of Engineers. At present only four companies, with a total strength of 450 enlisted men, are allowed to be recruited.

The aggregate strength of the battalion on June 30, 1888, was 15 commissioned officers and 388 enlisted men.

During the past year Companies A, B, C have been stationed at Willets Point. Company D exists only in name. Company E has been stationed at West Point to assist in the practical instruction of cadets of the Military Academy in building military bridges, sapping, mining, and signaling.

The following is a roster of officers serving with the battalion on June 30, 1888, viz:

Maj. W. R. King, Corps of Engineers, commanding.
First Lieut. J. G. Warren, Corps of Engineers, adjutant.
First Lieut. Irving Hale, Corps of Engineers, quartermaster.

Company A.

Capt. S. W. Roessler, Corps of Engineers, commanding company.
Second Lieut. M. M. Patrick, Corps of Engineers, with company.
Second Lieut. T. H. Rees, Corps of Engineers, with company.

Company B.

Capt. Edward Maguire, Corps of Engineers, commanding company.
Second Lieut. Charles S. Riché, Corps of Engineers, with company.
Second Lieut. F. R. Shunk, Corps of Engineers, with company.

Company C.

Capt. Eric Bergland, Corps of Engineers, commanding company.
Second Lieut. H. C. Newcomer, Corps of Engineers, with company.
Second Lieut. Charles L. Potter, Corps of Engineers, with company.
Second Lieut. J. J. Meyler, Corps of Engineers, with company.

Company D.

First Lieut. J. G. Warren, Corps of Engineers, commanding company.

Company E.

Capt. P. M. Price, Corps of Engineers, commanding company.
First Lieut. J. Biddle, Corps of Engineers, with company.

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The following table shows the changes that have taken place in the personnel of the officers during the year, viz:

Rank.	Names.	Date.	Joined or relieved.	Remarks.
First lieutenant	Chittenden, H. M	July 6, 1887	Relieved	S. O. 151, A. G. O., July 1, 1887.
Do	Sibert, W. L	July 6, 1887	...do	S. O. 152, A. G. O., July 2, 1887.
Second lieutenant	Shunk, F. R	Oct. 1, 1887	Joined	S. O. 227, A. G. O., Sept. 29, 1887.
Do	Meyler, J. J	Oct. 1, 1887	...do	Do.
Captain	Knight, J. G. D	Nov. 15, 1887	Relieved	S. O. 262, A. G. O., Nov. 10, 1887.
First lieutenant	Biddle, John	Dec. 22, 1887	Joined	S. O. 272, A. G. O., Nov. 22, 1887.
Second lieutenant	Kuhn, J. E	May 10, 1888	Relieved	S. O. 101, A. G. O., May 2, 1888.
Do	Craighill, W. E	June 30, 1888	...do	S. O. 141, A. G. O., June 19, 1888.

Capt. S. W. Roessler, Corps of Engineers, was relieved from duty as battalion and post adjutant and treasurer, recruiting officer, and acting signal officer, post of Willets Point, and from command of Company D, Battalion of Engineers, in Orders No. 253, Post of Willets Point, and Orders No. 95, Battalion of Engineers, December 6, 1887. Relieved from duty as inspector of rifle practice, Battalion of Engineers, in General Orders No. 14, headquarters Corps of Engineers, December 17, 1887. Assigned to command of Company A, Battalion of Engineers, in Orders No. 86, Battalion of Engineers, November 15, 1887.

First Lieut. J. G. Warren, Corps of Engineers, was relieved from duty with Company E, Battalion of Engineers, on December 5, 1887, in compliance with Special Orders No. 272, headquarters of the Army, Adjutant-General's Office, November 22, 1887, and appointed battalion adjutant and treasurer, in command of Company E, Engineers, in Orders No. 95, Battalion of Engineers, and post adjutant, treasurer, recruiting officer, and acting signal officer, Post of Willets Point. In Orders No. 253, Post of Willets Point, December 6, 1887; inspector of rifle practice, Battalion of Engineers, in General Orders No. 14, headquarters Corps of Engineers, December 17, 1887.

First Lieut. John Biddle, Corps of Engineers, was appointed recruiting officer, Company E, Battalion of Engineers, at West Point, in Orders No. 103, Battalion of Engineers, December 24, 1887.

RECRUITING.

During the past year the companies of the battalion have been recruited, partly by enlistments and re-enlistments at Willets Point and West Point, and partly by assignment of recruits from principal depot, general recruiting service at David's Island, New York Harbor.

On February 16, 1888, application was made to the Adjutant-General U. S. Army, through the Chief of Engineers, U. S. Army, for the assignment of sixty recruits and three trumpeters. This application was renewed on May 25, 1888. The superintendent of the recruiting service, in compliance with instructions from headquarters of the Army, Adjutant-General's Office, dated June 1, 1888, directed on June 9, 1888, twenty recruits to be assigned to the Engineer Battalion. The three trumpeters joined from David's Island and were assigned to the Engineer Battalion on April 26, 1888, in accordance with instructions from headquarters recruiting service.

The following is a summary statement of the recruiting, desertion,

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and other changes among the enlisted men of the Battalion of Engineers during the past year, viz:

Recruits from depot	89
Enlisted in the battalion	9
Re-enlisted in the battalion	24
By transfer	1
From desertion	11
Total	134

Discharged:	
By expiration of service	22
For disability	16
By sentence of general court-martial	11
By order	14
By letter	1
Transferred	15
Died of disease and accident	4
Dropped from rolls	1
Deserted	49
Retired	1
Total	134

During the year the battalion has been drilled and instructed as follows:

1. Infantry tactics, school of the soldier, company, and battalion.

2. In target practice, during the months of June, July, and August, in the last target year, 152 men qualified as marksmen and 7 men as sharpshooters.

3. In pontoniering, during the months of August and September, including rowing, and building canvas batteaus and trestle bridges, as prescribed in the ponton manual.

4. In military engineering, including field fortifications, sapping, and military mining.

5. Torpedo drills were had throughout the year, the winter months being devoted to in-door drills and practice in the loading-room, and the summer months to outdoor drills and exercises.

6. Photography: Selected details of non-commissioned officers and privates have been instructed in military photography. (For details see Appendix E.)

7. Astronomy: The officers under instruction were practiced in the use of the sextant, transit, and zenith telescope.

8. In April, 1888, First Lieut. John P. Wisser, First U. S. Artillery, reported at the post under orders from the War Department, and practically demonstrated to the officers the workings of a system of instruction in the minor operations of war. A detailed report of his work was forwarded April 21, 1888.*

EXPERIMENTS.

As there has been no appropriation for torpedo experiments for the last two years, but little has been attempted in that direction.

Anything in the way of an extended or systematic course of experiments, either in electricity, explosives, or their combination in mining operations, involves expense, which could not be provided for without proper appropriations.

A few years ago the popular notion was that torpedoes would enable us to dispense with sea-coast fortifications, but now the idea seems to

* Omitted.

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be to dispense with torpedoes also, and trust to luck or some system of defense that will come up spontaneously when needed.

There is no doubt but that the efficiency of torpedoes, like most things that are suddenly brought into public notice, has been greatly overestimated even by military authorities, but they are now settling into their proper relative importance as a powerful auxiliary to, not substitute for, sea-coast fortifications, their value consisting very largely in their moral effect on the enemy and the delay which they will cause when armored ships attempt to run past shore batteries.

To be of any use, therefore, our system must be kept abreast of the most advanced developments of foreign nations, not only in general arrangements but in all their details, and especially in the all-important elements of *simplicity* and *certainty* of action.

We can not afford to lag behind in anything so vital to our national defense.

At the close of the late war we were in advance of all other nations in the knowledge and use of torpedoes, and although but little progress had then been made in their development as compared with what has since been accomplished, foreign nations were anxious to learn all they could from *us*. Now they are not only independent, but we can take lessons from them in such matters, as well as in ordnance and armor, ship-building, and in fact all that relates to sea-coast defense, not only to such nations as Great Britain and Germany, but to Italy and Spain.

With such facilities as were available a few miscellaneous experiments were made during the year, as follows:

1. Two grand groups of torpedoes were planted and tested as nearly as practicable in the way it would be done in actual service.

One of these groups was allowed to remain from November till May, to test the effect of winter weather, and in both cases complete records were kept of the time required to prepare and plant the mines, the difficulties encountered, and the conditions of the different parts at different times as shown by electrical tests and by careful inspection when the groups were taken up. Some of the details of these operations and suggestions relative to the subject are given in the report of Captain S. W. Roessler, hereto appended, Appendix D.

2. The electrical testing of torpedo cable, to ascertain its condition and rate of deterioration, has been continued; and much useful but very discouraging information relative to the condition of the cable in store has been obtained and recorded. Some of the results obtained are given in Captain Roessler's report just referred to, and will, I think, justify the following conclusion from my last annual report, viz:

> Enough has been learned, however, to justify the conclusion that the greatest care must be taken to preserve the insulating material of the cables, whatever their style of manufacture, or they will be found worthless when required for use, and if any better means can be devised than either the dry or wet storage as now practiced, it will be a valuable discovery.
>
> One plan that suggests itself, and might be worth investigating, would be to buy and store the cable in tanks without the armor, and store the wire for armor in dry warehouses until the cable is required for use, and then apply the armor as the cable is being reeled out of the tanks for shipment. This last operation would require a number of machines to be in readiness so as to cause no delay in getting the cable on board, and if worst come to worst, some of the cable could be laid temporarily without armor in the least exposed places, and afterwards replaced by armored cable when a sufficient quantity became available. This system would require concrete tanks for storage of the cable, but they would not require to be very large, as the unarmored cable is very much smaller in cross-section. The number and cost of the machines for applying the armor is a matter for investigation, but it is probable that neither of these items would be very large. Ten machines could armor 25 miles or more of cable in a single day, and this would secure absolutely reliable insulation at the time the cable was needed for use. If not needed at all, the cost of armor would be saved, as the wire could be used for other purposes.

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3. A series of experiments was made to ascertain the form and dimensions of the craters produced by different charges fired at various depths below the surface of the water.

These experiments were in continuation of some investigation made by me twenty-three years ago, when the first recorded attempt was made to measure the force of submarine explosions.

The apparatus consisted of a wooden frame 15 feet by 18 feet square, with a thin iron ring just below the center (as shown on Plate I), this ring being held in position by 16 radial wires, making angles of 22½ degrees with each other and having their outer ends attached to the wooden frame. Upon each wire was placed a small sliding block of hard wood 2 inches in diameter at the end towards the ring and much smaller at the outer end, the length of the blocks being 4 inches, and their density about the same as that of water. A small piece of rubber tubing was placed on the wire outside each block, the object being to record the distance to which the blocks were forced outward by the explosion of the charge, which was placed in the center of the ring.

The charges were inclosed in paper cartridges, coated with paraffine, and were exploded with platinum fuses containing only a little granulated gun cotton, instead of the usual priming of mercuric fulminate. The charge was generally of musket powder, only a few of dynamite having been tried.

The frame containing the ring and charge was lowered vertically into the water to the desired depth, and after firing the charge was raised, and the distance to which the sliding blocks were forced back was carefully measured and plotted, as shown on Plates II and following. In a few cases the water appears to have leaked into the charge and somewhat reduced all the indications of that round, but, on the other hand, as nothing could have caused any excess in the result, it is safe to assume that the maximum set of indications for a given charge were very nearly correct.

Although but few experiments have yet been made, the following conclusions are thought to be warranted:

(*a*) When a charge, of either gunpowder or dynamite, is fired under water, a large volume of water is displaced, forming a crater or cavity, spheroidal in general shape, and varying in size, according to the weight, nature of charge, and depth in the water.

(*b*) There appears to be a strong tendency to retain the spheroidal form, even when the depth below the surface of the water is considerably less than the line of least resistance that would give a "common mine crater" in ordinary earth, with the same charge.

(*c*) Charges exploded near the surface give larger craters and greater depressions below the center of the charge than those fired at greater depths.

(*d*) While the surface of the cavity formed by the explosion is generally quite regular in form, there are frequent exceptions to this rule which indicate that for some reason the expanding gas sometimes sends out small jets to a considerable distance beyond the general surface of the cavity. These jets are sometimes downward, but oftener in an upward direction, as would be expected.

(*e*) By standing on a wharf, nearly over the smaller charges, when they were fired, it was noticed that the inflamed gas formed a well-defined ball of fire, and by means of photography some tolerably successful efforts have been made to catch a view of what takes place at the very instant of explosion.

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(*f*) The action of dynamite in forming a crater seems to be quite similar to that of musket powder, though, of course, a much smaller charge produces an equal cavity.

4. A few experiments were made with paper discs, secured to a large iron ring which was used in the same way as the crater gauge already described for getting the form and size of the cavity formed by the explosion of small charges of powder and other explosives under water, but no satisfactory results have been obtained, as the paper manifested a disposition to tear out radially in such a way as to make it uncertain how much of the effect was due directly to the explosion and how much to the action of the water.

5. Some explosions were made for the purpose of breaking up the wreck of the schooner sunk near the long wharf by the steamer *Idlewild* in 1887. This wreck was in the way of navigation and was entirely broken up by a few charges of dynamite and common powder. The fragments were nearly all removed by the waves and the balance by a steam-tug.

6. Experiments have been begun with the electric search-light, and it is hoped that a practical combination can be made that will be available in case of actual attack on our harbors. The plant for this purpose must be simple, compact, and portable, as well as capable of throwing a powerful beam of light to a great distance, and it is not unlikely that some form of gas-engine burning liquid fuel will be found best for driving the dynamo.

7. The existence of two 15-inch guns, a large quantity of torpedo cable, and a dynamo in close relation to each other suggested the possibility of making the most powerful electro-magnet in the world with very little of expense, and the opportunity was taken to make some experiments in electro-magnetism on a large scale.

The two guns, weighing each 50,000 pounds, were placed side by side and connected at the breech by a pile of railway bars, as shown in the drawings, Plate III.

About 4 miles of insulated wire was coiled around each gun, and an armature or keeper was made of fifteen wrought-iron plates, each 11½ inches wide and half an inch thick. This armature, as well as the pile of rails forming the base of the magnet, was much too small to give the best results, and a much greater length of wire would have been desirable, but was not available, and the results obtained with the combination, as it was arranged, were a sufficient demonstration of the possibilities of this invisible power.

Four 320-pound shells were suspended from one of the guns and it required a pull of 20,600 pounds to detach the armature. The lines of force were easily traced to a distance of 20 feet or more by suspending pieces of soft iron wire so that they could take up the directions of these lines. Plate IV shows the direction of the lines of force in a horizontal plane through the axes of the guns and extending over 4 feet from the plane of the muzzles.

At a distance of 46 feet the magnet formed by one of these guns neutralized the earth's magnetism, and at 20 feet pieces of wrought-iron wire magnetized by induction so that they would hang together.

Some interesting facts were noted in regard to the direction of the lines of force, among which was the existence of a neutral point in the axis of the bore of the guns and 7½ inches from the plane of their muzzles. A spike or bit of iron placed inside of this point would be thrown beyond it, sometimes to a distance of 25 inches from the gun, returning suddenly to the face of the gun; but if placed on a board at the neu-

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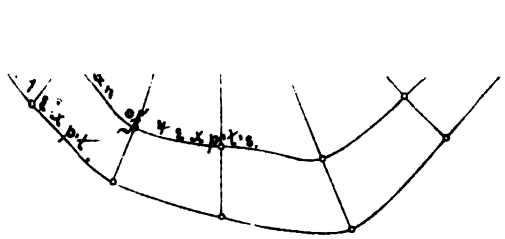

IMPROVISED ELECTRO-MAGNET.

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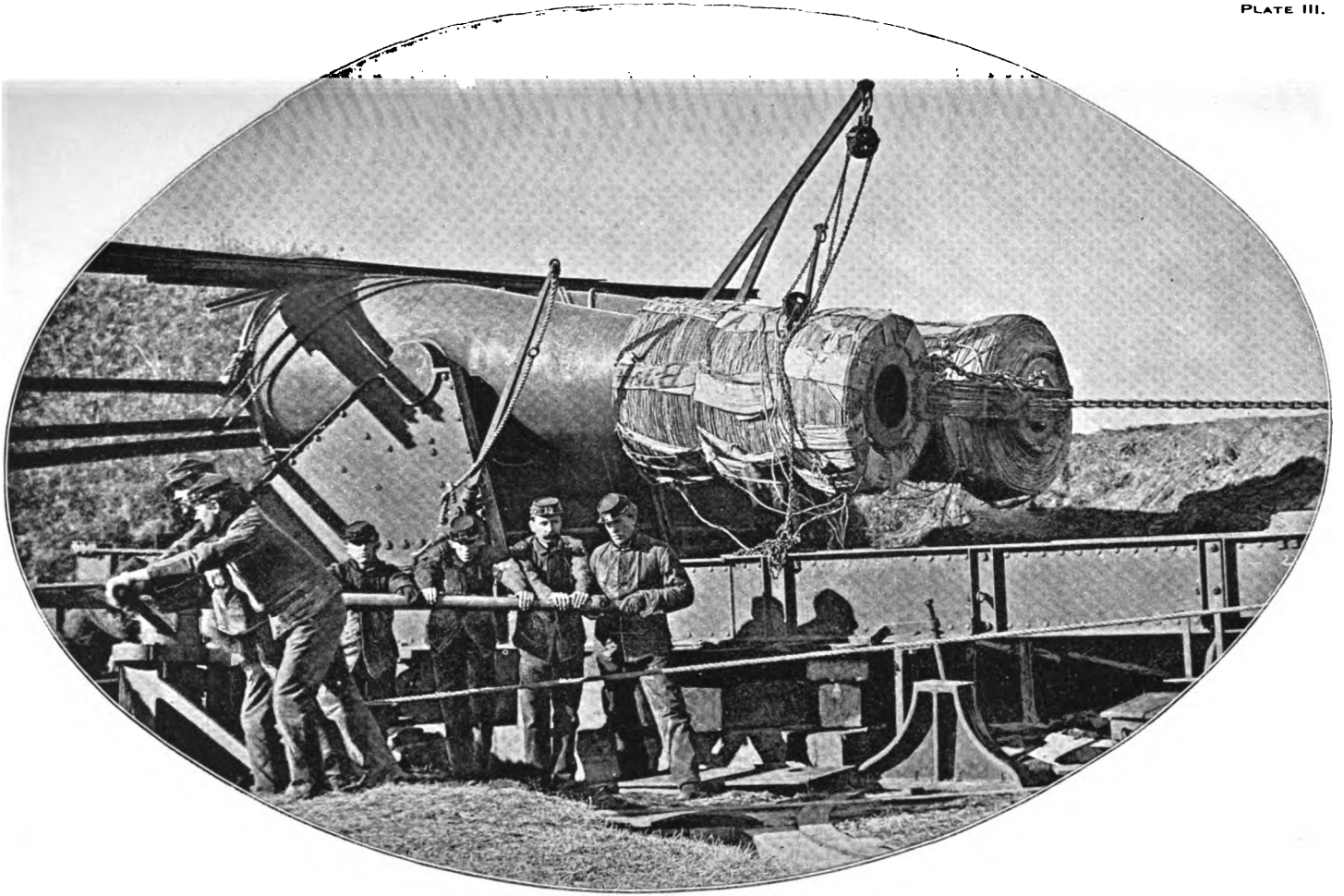

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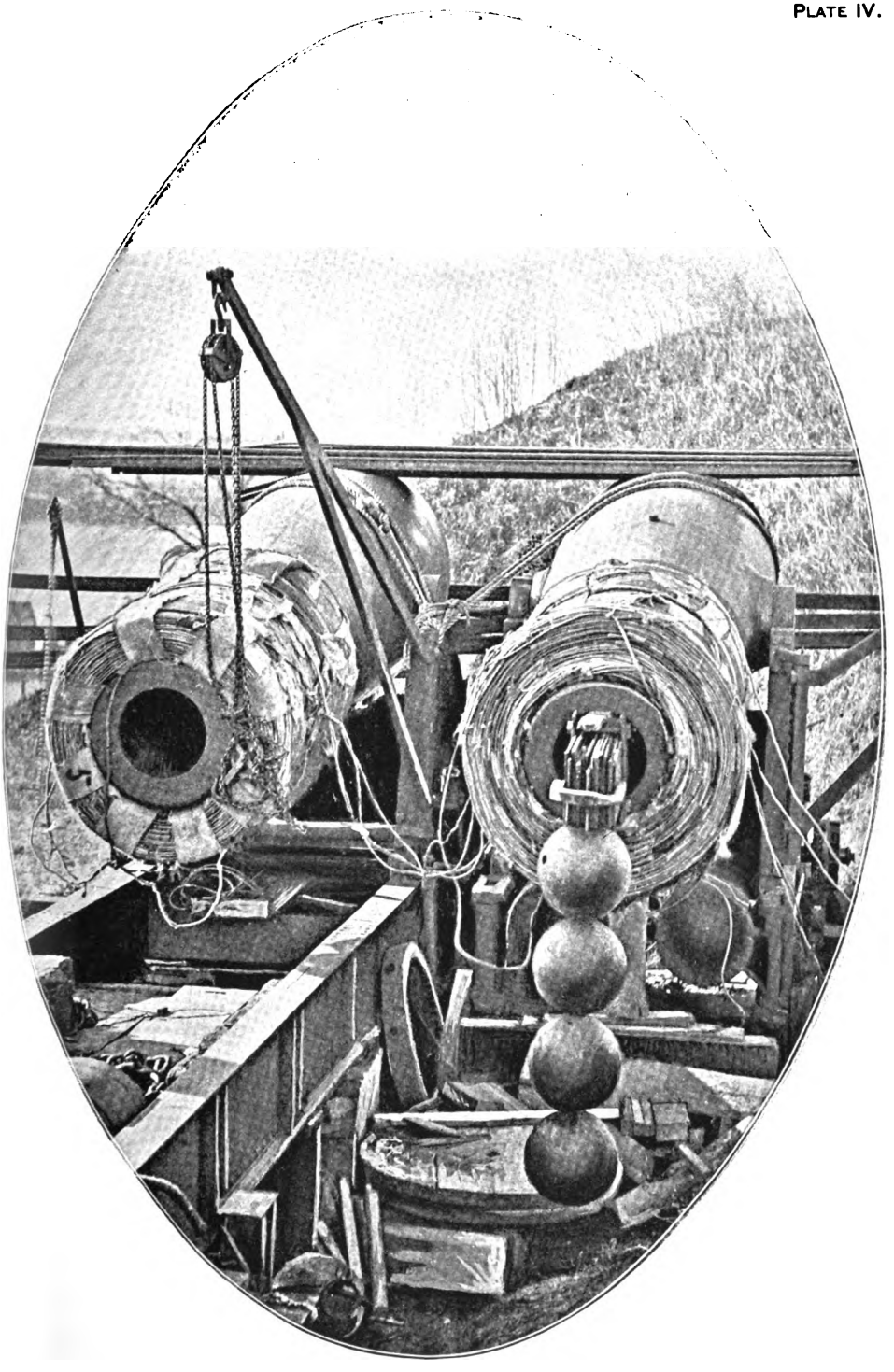

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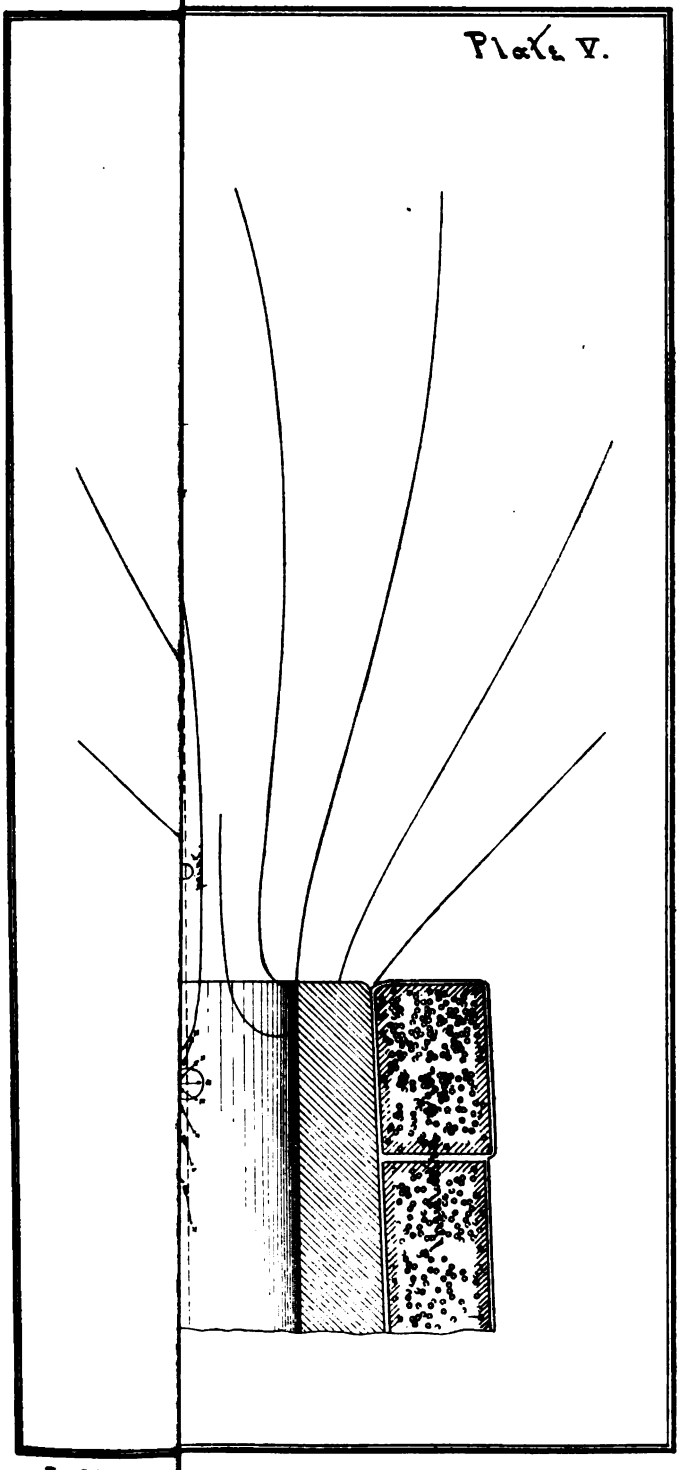
Plate V.



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tral point it would remain there and resist any force moving it either towards or from the gun. A similar point was noticed inside the bore of the gun and about 5½ inches from the face of the muzzle. When a 320-pound shell was placed inside the gun in was forcibly pushed out and remained attached to the lower side of the muzzle of the gun. (Plates III. & IV.

ENGINEER DEPOT.

PUBLIC BUILDINGS AND CONSTRUCTIONS.

The building for an officers' mess, library, etc., was completed and occupied during the year, excepting the actual transfer of books to the library, which has been delayed for want of suitable book-cases. These are now making from such materials as could be picked up by enlisted men, and when completed the library will be fairly well provided for.

The observatory dome has been repainted, and water has been brought into the officers' laboratory.

The rebuilding of the laboratory for enlisted men has been delayed an entire year by the failure of Congress to make an appropriation for it, but if the item for that purpose in the pending army appropriation bill becomes a law work should be begun at once, as the building is urgently needed for the proper instruction of enlisted men in torpedo service.

Other public buildings are referred to in the post report.

The steamer *David Bushnell* was hauled out on the ways last fall and should have been repaired and launched in the spring as soon as the ice was out of the way, but there was no appropriation for the purpose, and the repairs needed are quite extensive.

This steamer was designed and built several years ago for the purpose of planting torpedoes, but the propelling and steering arrangements, which are the Mallory type, have proved so unsatisfactory that it is not thought advisable to repair them, but rather to replace them by the ordinary propeller and rudder. Although she has run less than 2,000 miles since she was first launched the main-gear wheels and several other vital parts are entirely worn out.

Her deck needs calking, and it will be done at once by a detail of enlisted men, but before the repairs to her machinery are begun it is proposed to have the whole vessel thoroughly examined by an expert.

All repairs necessary for the preservation of depot buildings and depot property have been made.

DEPOT PROPERTY.

The surveying, astronomical, and other instruments in depot have been properly cared for, and some additions have been made by purchase of transits, levels, and other instruments likely to be called for by officers in the field.

Instruments have been received and issued in compliance with orders and requisitions as follows:

Turned into depot.—Three theodolites, 3 transits, 5 levels, 4 barometers, aneroid; 2 barometers, mercurial; 1 thermometer, 1 case drawing instruments, 1 odometer, 12 prismatic compasses, 4 silver watches, 1 leveling rod, 1 transit and compass, 1 transit and level combined, 1 protractor, 1 goniometer, 1 compass, surveyor's; 2 compasses, pocket, round; 2 psychrometers, 1 current meter.

Issued from depot.—Two theodolites, 2 transits, 2 levels, surveyors; 3 chains, 100 feet; 3 tapes, steel, 50 feet; 2 plane tables, 1 protractor, Abbot's; 2 prismatic compasses 3 hand-levels, reflecting; 6 odometers, 1 compass, pocket, square; 2 extra tubes for barometers, 1 solar attachment for transit, 1 level rod, 3 rulers, metallic; 1 case drawing instruments, 2 triangles, metallic, 2 triangles, rubber; 2 bridge rheostats.

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Most of the repairing of the instruments during the year has been done by detailed enlisted men, and the cost has been very much less than it would have been if the instruments had been sent out to private shops, while the character of the work done has been satisfactory.

The following instruments have been overhauled, cleaned, and put in good repair during the year, viz:

Two astronomical clocks, 4 boxes drawing instruments, 1 artificial horizon, 4 levels, 4 dial telegraph instruments, 2 dynamos, 2 chronometers, 1 sextant, 2 surveyor's compasses, 6 theodolites, 1 electric light, lens, and reflector, 1 orograph; besides a number of smaller instruments.

A small testing machine was improvised for measuring the tensile strength of wire, rope, etc., by using a Duckham dynamometer in measuring, and a jack-screw for applying the strains.

Another and more powerful machine, procured from the work recently in charge of the late General Gillmore, has been set up and will be used for testing specimens of building materials.

WORK OF THE DEPOT.

Printing, bookbinding, draughting, photographing, lithographing, engine driving, repair of depot buildings, and the general work to keep the property, buildings, and animals in a proper state of preservation, have been done by engineer soldiers, at a cost of $2,172.41, paid out of the appropriation for engineer depot at Willets Point, N. Y. Incidentals, 1888: Instruments were repaired at a cost of $140.70, paid out of the appropriation for Engineer Depot at Willets Point, N. Y. Instruments, 1888: For the latter payment special authority was obtained from the War Department.

The work of printing General Abbot's new Manual of Torpedo Drill has occupied most of the time of the printers.

The printing and bookbinding has been useful to every department here. Confidential and professional books for the officers of the corps, reports, blank forms, orders, circulars, etc., have been made promptly and with economy; professional periodicals were bound into volumes, and books pertaining to the library of the Engineer School of Application were rebound when necessary.

The blocks of granite which have so long occupied the open ground near and around the flag-staff and the Engineer Office were collected and piled as closely together as possible.

Materials required for the instruction of the Battalion of Engineers, in their special duties of sappers, miners, and pontoniers, have been purchased and issued for use here during the year, and the office work incidental to this and to the new mess building, with the necessary correspondence, money and property accounts, and required records, has been performed.

STATEMENT OF FUNDS.

Congress appropriated for the fiscal year ending June 30, 1888:

For incidental expenses of depot (incidentals)	$3,000.00
For instruction of battalion (materials)	1,000.00
For repair and purchase of instruments (instruments)	2,000.00
For purchase of professional works of recent date on military and civil engineering (library)	500.00
Total	6,500.00

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Of this there has been expended and pledged:

For incidental expenses of depot (incidentals)	$3,000.00
For instruction of battalion (materials)	1,000.00
For repair and purchase of instruments (instruments)	2,000.00
For purchase of professional works of recent date on military and civil engineering (library)	494.32
Total	6,494.32

No official notification has been received of the appropriation for the fiscal year ending June 30, 1889.

The following amounts have been assigned to me for disbursement, under extension, for the month of July, 1888, "under public resolution No. 20:"

Engineer depot at Willets Point, N. Y.:	
Incidentals, 1889	$350.00
Materials, 1889	83.33
Instruments, 1889	166.66
Library, 1889	41.00
Total	540.99

Which will be applied during the month of July as contemplated by law.

There will be required for the fiscal year ending June 30, 1890, the following, viz:

For incidental expenses of depot, including fuel, lights, chemicals, stationery, extra-duty pay to soldiers necessarily employed as artificers, on work in addition to and not strictly in the line of their military duties, such as carpenters, blacksmiths, draughtsmen, printers, bookbinders, lithographers, photographers, engine drivers, wheelwrights, teamsters, clerk hire, and for materials to repair public buildings, machinery, and unforeseen expenses	$5,000
For purchase of materials for instruction of Engineer troops in their special duties as sappers, miners, for land and submarine mines, pontoniers, torpedo drill and signaling	1,500
For purchase and repair of instruments to be issued to officers of the Corps of Engineers for use on public works, surveys, etc	2,500
For library of the Engineer School of Application; for purchase of professional works of recent date treating of military and civil engineering	500
For a small fire-proof building to contain the collection of engineering models used for illustration and instruction	8,000
In all	17,500

Very respectfully, your obedient servant,

W. R. KING,
Major of Engineers, in Charge.

The CHIEF OF ENGINEERS,
U. S. Army.

APPENDIX A.—COURSE OF WINTER INSTRUCTION.

[Printed Orders No. 233.]

ENGINEER SCHOOL OF APPLICATION, U. S. A.,
Post of Willets Point, New York Harbor, November 8, 1887.

The recommendations of the Academic Staff for the winter course of instruction, having been approved by the Chief of Engineers, are hereby announced. The course will begin on December 6, 1887, and extend to April 29, 1888, a period of twenty-one weeks.

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COURSE FOR OFFICERS.

1. Examinations by the Academic Staff will be held at the end of January and April, and intermediate examinations, as near monthly as practicable, will be held by committees of the Academic Staff. Marks at examinations will be on the West Point system, and the committees will report to the Commandant of the school the results of the examinations. As the efficiency of the instruction can be much influenced by the instructors, they will keep themselves fully advised of the progress of the students; will give them at any time any needed aid, and when the information on special subjects is difficult to obtain, should supplement the course by lectures. The instructors will meet their classes weekly, and assign the lessons for the following week.

FIRST WINTER'S COURSE.

2. The course for Engineer Officers spending their first winter at the school, and for Artillery Officers, will be submarine mining, nineteen weeks. The Engineer Officers will have in addition civil engineering, two weeks.

SUBMARINE MINING.

3. Nineteen weeks. (1) Parts I, II, III, Abbot's Manual (omitting Chapter V), and such parts of the following books as may be designated by the Academic Staff; (2) Abbot's Report on Submarine Mining; (3) Gray's Absolute Measurements; (4) Schleeman's Torpedoes. An essay is to be written between April 1 and 15, on use of explosives for demolitions and removal of wrecks and other obstructions to navigation by blasting.

4. Books of reference: Kempe's Electrical Testing; Murdock's Notes on Electricity and Magnetism; Eissler's Modern High Explosives.

5. The officers will be present at the electrical laboratory for six hours daily, Saturdays and Sundays excepted, while studying Abbot's Manual and Report. They will proceed to the laboratory at 9 a. m. Each officer will make all the electrical measurements specified in Abbot's Manual, excepting those in which the electrometer is used. Each measurement will be repeated six times independently, and the results will be reported weekly in writing through the instructor to the Commandant. Practice will be had in the duties of the loading-room as the officer in charge may direct.

CIVIL ENGINEERING.

6. (Two weeks after April 15.) Such portions as may be designated by the Academic Staff, of Johnson's Theory and Practice of Surveying.

SECOND WINTER'S COURSE.

7. Civil engineering, five weeks; military engineering, seven weeks; photography four weeks; submarine mining, four weeks.

CIVIL ENGINEERING.

8. (Five weeks.) Subjects: (1) Measurement of river discharge; (2) improvement of non-tidal rivers; (3) improvement of tidal rivers.

9. Text-books: Vernon Harcourt's Rivers and Canals; Schlichting's Improvement of Non-tidal Rivers.

10. Books of reference: De Bauve; Rankine's Civil Engineering; article on hydromechanics in Encyclopædia Britannica; Cotterill's Applied Mechanics.

MILITARY ENGINEERING.

11. (Seven weeks.) Subjects: (1) Modern guns, carriages, and projectiles; (2) steel, compound, wrought and cast iron armor; (3) modern ships of war and seacoast defenses; (4) modern fortifications, and their attack and defense.

12. Text-books: Such parts of the following books as may be designated by the Academic Staff: Woolwich Text-book of Fortifications; Maguire's Attack and Defense of Coast Fortifications; Fortifications of To-day; Inglis' paper in Professional Papers Royal Engineers, 1884, and a lecture on armored defense in Ordnance Notes No. 151; Very's Development of Armor; Naval Intelligence Papers, June, 1886; Adams' Spezia Experiments, 1886; Baylay's Types of Modern Guns; The Protection of Heavy Guns for Coast Defense, Sir A. Clark.

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13. Books of reference: Articles on Fortification and Gunnery, Encyclopædia Britannica; Ordnance Notes, No. 135, and Appendix; Volume 9, Professional Papers Royal Engineers; Report Board on Fortifications; Text-books on Gunnery, McKinlay.

MILITARY PHOTOGRAPHY.

14. (Four weeks.) Practice will be had in the following methods: Negatives by wet and dry processes; developers and intensifiers; silver printing, and finishing and mounting of the prints; map printing; photolithography, including the negative and transfer to stone and printing. Each officer to submit 12 printed copies of his map. Text-books: Griffin's Notes on Photography.

SUBMARINE MINING.

15. (Four weeks.) An officer of the second and third winter's course will be detailed weekly to report to the instructor in submarine mining, as assistant for testing core joints and instructing enlisted men on the torpedo detail.

THIRD WINTER'S COURSE.

16. Civil engineering, eleven weeks; military engineering, three weeks; submarine mining, four weeks.

CIVIL ENGINEERING.

17. (Eleven weeks.) Subjects: (1) Measurement of river discharge; (2) improvement of non-tidal rivers; (3) improvement of tidal rivers; (4) wave and current action, and improvement of harbors; (5) canals; (6) steam engines and pumps. Such parts of the following text-books as may be designated by the Academic Staff.

18. Text-books: Vernon Harcourt's Rivers and Canals, and Harbors and Docks; Schlichting's Improvements of Non-tidal Rivers; Edward's Steam-engine.

19. Books of reference: De Bauve, Manuel de l'Ingénieur; Rankine's Civil-Engineering and Steam-engine; Bixby's Pointe de Grave; articles on hydro-mechanics and steam-engine in Encyclopædia Britannica; Cotterill's Applied Mechanics; Jameison on Steam-engine; Steam-boilers, Wilson; Modern Steam-engine, Rose.

MILITARY ENGINEERING.

20. (Three weeks.) Hamley's Operations of War.

SUBMARINE MINING.

21. (Four weeks.) See paragraph on submarine mining in second winter's course.

COURSE FOR ENLISTED MEN.

INSTRUCTION OF ENLISTED MEN IN TORPEDOES.

22. Details will be for one week, and from the companies in turn, and will consist of 1 sergeant, 1 corporal, and 12 privates.

23. The details will spend the regular fatigue hours, Saturdays and Sundays excepted, at the old instruction building for enlisted men. Every soldier not excused by orders will be included on this list; but the roster will be arranged specially for the benefit of the recruits. Their instruction will be directed by the instructor in submarine mining, who will be assisted by the lieutenant detailed.

24. Instruction will comprise telegraphing with the dial instrument, including the code for action; the duties of the loading-room, and, so far as practicable, of the boat service as prescribed in the torpedo manual, comprising preparing the plugs of the buoyant and ground torpedoes; charging the mines; charging the cut-off boxes, three methods; jointing the cores; making turk's heads in the electrial cable; using the junction boxes; attaching a cable stop; splicing and knotting hemp rope; inserting thimble in wire mooring rope. They will also receive from the instructor in submarine mining or his assistant, daily lectures respecting the fuses, explosives, torpedo material (except that of the operating-room), voltaic batteries, simple electrical testing, and the use of the portable apparatus for the electrical ignition of mines. On Saturday the instructor in submarine mining will submit a report giving the names

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and proficiency of the detail, what verbal and other instructions they have received, and will give the insulation of the core joints made by them. Printed blank forms will be supplied.

INSTRUCTION OF ENLISTED MEN IN PHOTOGRAPHY.

25. Two non-commissioned officers will be detailed each week for instruction in map printing.

INFANTRY DRILLS.

26. Company commanders will see that their companies are kept well drilled in the manual of arms, and that they are practiced in gallery target practice, and when the weather is suitable in estimating distances. The hours of practice and of recruit drill will be regulated as may be most convenient. One company drill will be had at 3 p. m. by Company A on Wednesday, by Company B on Thursday, and by Company C on Friday of each week—recall being sounded at 2.30 p. m. for that company. The drill will be attended by all men except the foregoing details and men excused by orders.

COMPANY RECITATIONS.

27. The non-commissioned officers of each company in turn will receive one week's theoretical instruction. They will be excused from all duties but those necessary in the company. Recitations will be conducted daily (Saturdays and Sundays excepted) under the supervision of the company commanders. Company commanders may excuse non-commissioned officers from recitations in any subjects in which they are already proficient.

28. Regular classes will be formed in field fortifications (including mining), pontoniering, infantry tactics, the theoretical and practical use of the railroad transit. Each recitation will be marked on the West Point system, and at the close of each week a list, showing the marks of each non-commissioned officer, in each branch, will be forwarded to the commandant.

29. A school for soldiers will be established, as prescribed in the regulations of the Army. This school will be under the charge of the post adjutant. Sessions will be held between 7.30 and 8.30 p. m. on Tuesday and Friday of each week in the upper school-room. Weekly reports of progress will be rendered.

30. Company recitations of non-commissioned officers will be held in one or both of the rooms assigned to the post school for children, at the option of the company commanders; provided, however, that such hours are selected as will not interfere with the regular use of these rooms.

31. The following assignment of instructors is made:

Military engineering, Capt. E. Maguire, Corps of Engineers.
Civil engineering, Capt. E. Bergland, Corps of Engineers.
Submarine mining, First Lieut. S. W. Roessler, Corps of Engineers.
Military photography, the battalion quartermaster.

By order of Major King:

S. W. ROESSLER,
First Lieutenant of Engineers, Post Adjutant.

APPENDIX B.—PROGRAMME OF STUDY AND INSTRUCTION FOR SUMMER SEASON.

[Printed Orders No. 35.]

UNITED STATES ENGINEER SCHOOL,
Post of Willets Point, New York Harbor, April 20, 1888.

The following programme of study and instruction for the ensuing summer season, to commence May 7 and end November 17, 1888 (twenty-eight weeks), having been recommended by the academic staff and approved by the Chief of Engineers, will be carried into effect:

MILITARY ENGINEERING.

1st. Instruction by the company officers in the nomenclature, dimensions, and construction of modern siege batteries and saps. 2d. A full course of trestle and ponton drill. 3d. Instruction in military mining. 4th. Military map making in accordance with existing orders and instructions. Each lieutenant who has not already done so,

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and such non-commissioned officers and privates as may be selected from each company, will make satisfactory foot reconnaissances about 4 miles long in the vicinity of the post, the maps thereof to be submitted by company commanders to post headquarters on or before the termination of the season.

TORPEDO DRILLS.

The torpedo drills are separated into two divisions, viz:

1. The weekly torpedo drill, the programme for which is given below.

2. Planting a grand group of torpedoes as for service, using an inert substance in place of the explosive; testing and operating the group; and experience in the use of the electric light and in the adjustment of its machinery.

Weekly torpedo drills.

These drills will be had first, and continue until each officer has had at least two weeks' experience in their supervision—one week as in charge of operations on the water and one week as electrician. The weekly detail will consist of two officers, two non-commissioned officers, and twelve privates. The detail of officers will be made as far as practicable from the artillery officers until the first of July. The detail of enlisted men will be taken from the companies in turn. In the absence of commissioned officers the assistant instructor in torpedoes will be in general charge of the detail without regard to rank.

During the fatigue hours (except on Saturday and Sunday) the men will be instructed (1) in the duties of the boat service connected with submarine mines, and (2) in those of the loading-room; occasionally loaded mines will be planted and fired as in actual service.

The following system will be observed as closely as circumstances permit:

1st. MONDAY. *Judgment torpedo drill.* The mapping drill will first be practiced; then the judgment firing drill. A few steamers or sailing vessels should be tracked at every drill, and the diagrams will be neatly finished and preserved.

2d. TUESDAY. *Placing the junction boxes.* This drill will be simulated on land until the principles are fully understood by every member of the detail. It will then be executed on the river, using the base line between the fort and engineer wharf. Care must be taken, by providing buoy ropes of sufficient length, to avoid the loss of anchors.

3d. WEDNESDAY. *Planting a group of mines.* One officer will act as electrician, and the other will command on the steam-launch; the former, on Monday or Tuesday, will set up the apparatus completely in the mining casemate, so that everything shall be in readiness. All the tests used in planting a grand group will be made. Before the officer's detail is relieved, all the apparatus will be removed from the mining casemate, unless otherwise ordered.

4th. THURSDAY. *Automatic firing drill.* This drill must first be practiced at the wharf in the manner prescribed in the manual. Subsequently it may be combined with the judgment drill on the river.

5th. FRIDAY. *Planting a self-acting mine.*

6th. Daily instruction in rowing will be had between morning fatigue call and 8.30 a m.

In weather unfavorable for outdoor drill the detail will be exercised in the duties of the loading-room, in the shore duties pertaining to the boat service, and in the use of the dial telegraph, and verbal instruction will be given respecting the fuzes, explosives, torpedo material—except that of the operating-room—simple electrical testing, and the practical use of the ordinary forms of apparatus for the electrical ignition of mines.

The officer in charge will submit the plots of the mapping drills and weekly reports giving the names of the enlisted men; what they have been drilled in, and their classification as to proficiency; also personal reports from each officer showing what he has accomplished, with notes of his tests and a statement of any difficulty encountered and any suggestion he may desire to make.

Planting Grand Group, etc —After a proper amount of experience has been had in the above-mentioned drills the officers will be arranged in details, as the post-commander may direct, for the purpose of planting a grand group of torpedoes, testing and operating the system, and manipulating the electric light—an inert substance will be used instead of the explosive. The officers of the detail will frequently interchange duties so that each one shall have a fair amount of experience in all the details of the work. The senior officer will be in general charge; he will keep a daily journal of operations, noting particularly any difficulties encountered and any suggestions that may occur to him at the time, looking to the avoidance of similar difficulties in the future. The group and electric light being ready for service, the fact will be reported at once

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through the instructor to the post-commander, who may order an exhibition drill illustrating the operations of the torpedo defense against an attempted passage of the mines by an enemy's vessel under cover of night. The group will then be taken up by the same detail, and the parts dismantled and returned to their proper places.

Weekly reports of progress will be rendered by the senior officer of the detail, and at the conclusion of the work each officer will submit a report on the work done by him, mentioning difficulties encountered and any suggestions he may desire to make.

The attendance of the officers will be from 8.30 to 11.30 a. m., and from 1 to 4 p. m. When not actually engaged in supervision of the above-named drills, they will practice in the Morse system of telegraphy until messages are sent and received with facility.

The non-commissioned officers of the battalion will also receive practice in the Morse system of telegraphy at such times as they can be spared from their other duties.

CIVIL ENGINEERING.

The following instrumental surveys will begin as soon as practicable, and officers when detailed for this purpose will be excused from all other duties when actually engaged in the field-work. Each lieutenant who has not already done so will make and plot a careful instrumental survey of about one square mile of ground. The work will include contours with a surveyor's level. He will be assisted in the field-work by details of non-commissioned officers and privates from his company. The work will be plotted on a scale of 12 inches to the mile, with contour planes 10 feet apart. Good level bench-marks should be made and located on the map, the references being given a column of notes. The names of the residents should be recorded. A field azimuth of one of the lines will be determined astronomically. The finished maps will be submitted on or before the termination of the season.

A careful hydrographic survey of about one-quarter ($\frac{1}{4}$) of a square mile, including current measurements with electric current meter and double floats, will be made, if practicable, by the lieutenants who have not already done so.

FIELD ASTRONOMY.

All the lieutenants who have not already completed the course, and been excused from further observations, will constitute the observers, being called upon by the officer in charge as wanted. In addition, when officer of the day (except on Sundays), the weather permitting, they will observe the sun for time.

The following system will govern the observations at the observatory. The course covers two seasons—the first including sextant work, and transit and zenith telescope work, with the instruments in the east wing and on the outer pier; and the second including sextant work, practice with the new combined instruments in the west wing. Officers wishing to use the instruments for special observations or practice, must apply for authority to do so.

Suitable blank forms will be provided, both for observations and computation; and these original records, after inspection by the commanding officer, will be returned to the officers as their personal property.

The following allowance of time will be made for computations: Three days for a set of latitude observations with the sextant, for a set of time observations with the transit, for the value of a level division or for a micrometer turn with the zenith telescope, and ten days for latitude by the zenith telescope.

The following will be the ordinary routine of observations with the several instruments:

Sextant.—After becoming skillful in the use of this instrument upon the sun, observers will deduce at least one satisfactory latitude by observing a north and a south star, using the time deduced from an east and a west star—each based on ten altitudes taken on the same night. These observations for latitude and time must be made at the observatory, and the time results must be reported for the Lukens' chronometer. *No other record will be accepted.*

Transit.—A satisfactory set of time observations will be taken by each officer on two nights, successive if possible, the observer taking his own time.

Zenith Telescope.—Observers will first determine the level correction by daylight, using a distant terrestrial object, or at night using a slow circumpolar star. They will then find the value of a turn of the micrometer by observing Polaris at elongation. Lastly, they will observe for latitude, until they have obtained a satisfactory determination based on three nights' work upon not less than twenty pairs.

Astronomical Azimuth.—Each officer serving his second year will determine an astronomical azimuth—using a large theodolite for the purpose.

Each officer shall receive instruction in the use of the personal equation machine and chronograph, and in comparison of chronometers.

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MILITARY PHOTOGRAPHY.

The officers' laboratory will be open daily from 1.30 p m. until 4 p. m. The building, apparatus, chemicals, etc., will be under the charge of the battalion quartermaster, whose duty it is to furnish any desired assistance, and who will be held responsible for the judicious use of the property. Officers are invited to avail themselves of the advantages of the laboratory, making such arrangements with the officer in charge as shall insure no confusion in his official duties, or in those of the men under his instruction. The instruction of enlisted men will be restricted to one non-commissioned officer from each company, selected from those having special aptitude. They will be detailed singly for one week at a time, and will receive such instruction as, in the judgment of the officer in charge, is best suited to perfect their knowledge of the subject.

By order of Major King.

J. G. WARREN,
First Lieutenant of Engineers, Post Adjutant.

APPENDIX C.—ASSIGNMENTS TO CHARGE OF DEPARTMENTS OF INSTRUCTION.

[Printed Orders No. 90.]

UNITED STATES ENGINEER SCHOOL,
Post of Willets Point, N. Y. Harbor, April 24, 1888.

The following assignments to the charge of Departments of Instruction are announced:

Military Engineering, the captains in turn, excepting the instructor in torpedoes.
Astronomy, Capt. Edward Maguire.
Civil engineering, Capt. Eric Bergland.
Torpedoes, Capt. S. W. Roessler.
Military Photography, First Lieut. Irving Hale.

At the close of the season each officer will submit a report upon the work done in his department, with any recommendations he may desire to make. Weekly reports of progress will be rendered.

I. *Infantry Drills* (school of the company) will be had on Monday, Wednesday, and Friday of each week from May 7 until July 15, from 10.30 to 11.30 a. m. Recall from fatigue will be sounded at 10 a. m. for this purpose. Battalion drills will be had at such times as the post commander may order.

Excepting the non-commissioned staff, band and field music, provost sergeant, police sergeant, school teacher during sessions of the school, mail-carrier and ambulance driver, telegraph operator, one post baker, one stable orderly, two cooks and one barrack orderly from each company (the barrack orderly to be, if practicable, from among those who are sick in quarters); nothing in existing orders shall be construed as excusing any soldier whether on extra or daily duty from attending these drills.

II. *Drills in Military Engineering* will be had daily, Saturdays and Sundays excepted, during the months of August, September, and October.

The companies will be consolidated as one company under the command of officers detailed from these headquarters; unless so detailed officers will not be required to attend. The captains of companies, excepting the instructor in torpedoes, will be detailed in turn to supervise these drills. The drills will commence at 1 p. m. and continue until 4 p. m., or until the completion of the particular work laid out for the day.

The months of August and September will be devoted to ponton exercises. August will be mainly devoted to drills on land, including building trestle bridges, loading the wagons, and putting together the canvas ponton boats. September will be devoted to drills on the water, including the construction of bridges and boat maneuvers. October will be devoted to instruction and practice in field fortifications, sapping, and military mining.

Extra and daily duty men, with the exceptions heretofore noted for infantry drills, will be required to attend an average of at least one drill per week on military engineering, and officers having charge of extra and daily duty men will send to the companies timely lists of those who are *not* to attend each day.

III. *Surveys and reconnaissances* as required by Orders No. 85, current series, will be made if practicable during the months of May, June, and July.

IV. The months of May and June having been designated as the target practice season, practice will commence on May 1.

V. Beginning May 1, dress parades will be had daily, Saturdays and Sundays excepted. First call will be sounded half an hour before sunset.

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VI. The following are excused from dress parades: Police sergeant; provost sergeant; 2 cooks and 1 barrack orderly for each company; 2 post bakers; torpedo, depot, and photographic sergeants; mail-carrier; 1 post clerk; 1 stable orderly.

The following are excused from Sunday morning inspection: Police sergeant; 2 cooks and 1 barrack orderly in each company; driver of ice-cart; mail-carrier; 1 stable orderly; telegraph operator; 2 post bakers.

VII. Company recitations will be discontinued after the first proximo.

VIII. On and after the 30th instant, all formations under arms will be in full dress, without blanket bags, canteens and haversacks, excepting at infantry drills, at which undress with forage caps will be worn.

IX. On and after the 30th instant, the triangular bayonet will be substituted for the trowel bayonet.

By order of Major King.

J. G. WARREN,
First Lieutenant of Engineers, Post Adjutant.

APPENDIX D.—REPORTS OF CAPTAIN S. W. ROESSLER, CORPS OF ENGINEERS.

(1.)

WILLETS POINT, NEW YORK HARBOR, *July* 12, 1888.

SIR: I have the honor to submit the following report on the torpedo department for the year ending June 30, 1888:

The work of the year consisted mainly in carrying out the programme of study and instruction as announced in post orders, viz, out-door drills and exercises on the water during the summer season, and in-door work, theoretical and laboratory studies during the winter season. In addition, two grand groups of torpedoes without explosive charges have been planted, partly for experimental, and partly for drill purposes. Their performances, which have not been entirely successful, have been subjected to as close an analysis as the data would permit.

FIRST GRAND GROUP.

This group was planted in October and November, 1887, under the immediate direction of Captain Knight, and was raised in May, 1888, after an endurance test of about six months. It consisted of five groups of three mines each, and two groups of two mines each. Two torpedoes were ground mines of the latest pattern; the remainder were buoyant mines with galvanized steel cases. The explosive and charge-bag were omitted. Circuit regulator plugs were used in all the mines, but with magnets removed from some of them. Day's kerite cable, multiple and single, was used throughout. The former (drum D) has been submerged since 1881, and frequently applied to experimental and drill work since.

All work required in connection with the group was done by picked men, and special care was taken to insure good workmanship.

During the winter season, from the beginning of December to the end of April, the mines were tested, when practicable, every working day of the week by the officer of the weekly detail, or by one of the officers taking the winter's course. Both the resistance test and sea-cell test were applied. The results of the resistance tests are tabulated, giving for each week the average of all the tests made during that week.

During the raising of the mines, after the switch-box had been raised and cut out, the mine cables were successively connected with the cable leading back to the grand junction-box and the resistances of the mines determined separately. From these it was easy to calculate what the resistance of each group should have been if there were no leak in and around the mine switch. The last line in above table gives the resistances of the groups so calculated.

The tests of November 21 exhibit the condition of the group just after planting. They show that all the mines were serviceable, and the mine resistance nearly normal, excepting that of triple group No. 7, whose resistance was 1,090 ohms.

Assuming 500 ohms as the lowest limit to which the resistance of a triple group may safely fall in main-line firing, the tests show that within four weeks after planting, two triple groups had become unserviceable; that a third group failed within six weeks, and a fourth within nine weeks, and a fifth within about seventeen weeks, leaving only two groups out of the original seven in proper condition for main-line firing. The failures were due mainly to (1) leakage through the gland stuffing-boxes into the fuze-can and into the chambers of the mine switch, and (2) to injury to the cable insulation. Lieutenant Pope, who personally superintended the raising and

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dismantling of the group, reports that "considerable leakage was shown, both in the cut-off bones and in the plugs, the fuze-cans in three of the mines containing water, one nearly full. In some cases the "A" wire had the insulation twisted off near the rubber packing. The leakage appeared to have taken place along the wire and not by the screw-threads of the gland." The failure of groups 1, 4, and 7, so far as their resistances were brought below the 500-ohm limit, was due to leakage in and around the mine switches. Group 1, at last test in April, gave a resistance of 258 ohms; the calculated resistance of the group with the switch-box cut out was 1,490 ohms. Group 4, at last test in April, gave only 18 ohms resistance; with switch-box out the resistance was 2,054. The group consisted of only two mines, so that the resistance would have been nearly normal but for the faults in the switch-box. Group 7 gave a resistance of 51 ohms with switch-box in circuit, and a resistance of 683 ohms with switch and its faults removed. The failure of the remaining two defective groups is attributable largely to leakage into the fuze-can and injury to cable insulation. As to the injury to the cable insulation, Lieutenant Pope reports that "the armor of the single-conductor cable was found to have been badly twisted, in every case immediately below where it was lashed to the bales, and in some cases the insulation of the cores injured. In one case, that of a ground mine, the armor was entirely divided, evidently by corrosion due to some local cause, and the core separated. This damage was in the cable leading from the grand junction-box and within 2 feet of the mine, where the cable could not have been subjected to considerable motion or strain."

The sea-cell tests were always made in connection with the resistance tests, and much thought and study were given to them at first with the view of determining from their indications the probable cause or causes of the failure of the mines. Owing, however, to the disparity of the indications no definite conclusions could be drawn, and the tests came to be regarded by all who made them as of doubtful value. In the drills so far carried out this season the sea-cell tests have not been applied, the resistance tests being accepted as the only safe guide.

The galvanized steel cases were found practically free from rust after their six months' exposure to the action of sea-water.

SECOND GRAND GROUP.

The group was planted in June under the immediate supervision of the artillery officers (Lieutenants Pope, Ridgway, and Parker). Each officer having had one week's preliminary experience in charge of the boat parties and one week's experience as electrician. The mines were all arranged for both judgment and automatic firing. A 100-pound mixture of sand and sawdust was used in place of the regular charge of dynamite. The multiple cable was that used in the winter group. The single-conductor cable was taken from a drum of the Silvertown purchase of 1874, which had given an insulation resistance of over three megohms per mile at 75° F., after two weeks' submersion. The following are the principal points of our experience with the group:

Considerable care had to be taken in putting together the circuit closer as the ball is liable to stick fast in some positions of the plug if the adjustment is not made with accuracy.

Much difficulty was experienced in adjusting the magnet of the circuit regulator. The adjustment is so extremely delicate that the slightest turn of the screw which regulates the pressure of the spring against the magnet may make the pressure too heavy or too light. In the case of one regulator, adjusted to work well one day, the magnet proved to be out of adjustment the following day. A modification of this mechanism to make it easier and more certain of adjustment is necessary to insure its success in the hands of an officer of average experience.

The fault of the untwisting of the armor of the cable below where it is lashed to the bales of the torpedo was shown in this group, although some of the mines remained in position only one week. The fault does not appear to be due to chafing, but to the motion of the mine. In the grand group now being planted the effect of a wrapping of marlin or iron wire applied to the cable to a point from 3 to 5 feet below the mooring ring will be investigated. Two wrappings of armor wire in opposite directions would doubtless be the best solution to the difficulty.

The presence of moisture in one of the mines was found to have a marked influence on the mine resistance, reducing the latter to nearly one-half its normal value. The difficulty was removed by dismantling the torpedo and drying all its parts. It is supposed that the charge and charge-bag, when moist, are semi-conducting, and thus constitute a shunt circuit between the zinc plate of the regulator and the metal of the torpedo case. It would be of value to know the behavior of a dynamite charge under similar conditions.

Owing to the close fit of the mine switch between the Turk's heads in the tripple junction-box, there is danger, when the switch-box is placed in position, of injuring

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the insulation of the wires by bending the latter sharply at the glands. An enlargement of the interior space of the junction-box or a reduction in the size of the switch-box is desirable.

The mine switch, when loaded with the service cut-off, containing four grains of fulminate, has not given satisfactory results, earth being frequently made through the box. A number of trials has been made with the mechanical cut-off fuze described in Abbot's Manual, and in each instance with perfect success.

I desire here to invite special attention to a few points in the present organization of the torpedo department which, in my opinion, are open to grave objections.

The organization is given in Abbot's New Torpedo Manual, as follows, page 99 *et seq.*:

"Upon the approach of hostilities, officers of engineers will be selected to direct the planting and operating of the submarine defenses at the channels to be obstructed."

"They will be provided with specific orders and plans showing the number and location of the mines, and will make requisition upon the Battalion of Engineers and the Engineer Depot for instructed enlisted men and the needful material."

* * * * * * *

DUTIES OF THE COMMANDING ENGINEER.

"His requisitions will first demand the attention of the commanding engineer; but before they can be drawn up correctly he must settle one matter which has been left undecided in the approved local projects of the Board of Engineers," viz: "The locus of the circuit regulators," whether they should be placed in the torpedoes themselves or in separate buoys planted some 50 or 100 feet in rear of the torpedoes proper for the purpose of baffling the enemy's defensive outriggers. The manual then mentions some of the conditions that would enter in a decision of this question, and proceeds:

"It will be for the officer, after considering the conditions of his special problem, to decide what proportion, if any, of his mines shall be planted with detached circuit regulators, for which provision has been made in planning the details of the system." * * *

"In one contingency, not unlikely to occur, a radical modification may be necessary in the projects of the Board of Engineers, and hence in the requisitions for material, viz, when from deterioration in store the supply of insulated cables is insufficient for the demand." * * *

First. The officer who will be charged with the torpedo defense of a harbor and be held responsible for its success is not designated until the approach of hostilities.

The torpedo service is technical in its requirements and a working familiarity with all its details is necessary to insure success. The detail of an officer for this duty will be made from among those who have taken the torpedo course at Willets Point, perhaps many years before. Being engaged in the interim in other duties he will have forgotten much that he has learned, and at the time of his selections will in all probability not have a working knowledge of the system, and this I do not believe he can acquire in the short time given him. Why should his problem and the fact of his selection be withheld from him until the last moment? Why should not the selection be made years in advance, so that the officer may have the important advantages of time and careful preparation for his work?

Second. The officer is required to decide the question of the locus of the circuit regulator.

The conditions which enter into a decision of this question can be determined in time of peace, as well as in war. The matter should therefore be definitely settled in peace time or left out of consideration altogether.

Third. The officer himself is required to make up the list of material required for his harbor.

Many objections could be urged against this provision, but I need mention only one, viz: There is no necessity for postponing the preparation of this list till the outbreak of hostilities, because it can be done just as well in time of peace. The torpedo officer should be required to plant and to operate, and not to provide. The latter duty devolves particularly upon the commanding officer of the engineer depot.

A modification of the organization upon the following basis is suggested as in the direction of a better state of preparedness for actual war service:

I. The plans of the torpedo defense to be prepared by the Board of Engineers in sufficient detail to permit the preparation of a complete list of material.

II. A copy of the Board's plan should be furnished to the commanding officer of the engineer depot, whose duty it would then be to prepare the list of material required and to provide, as far as the appropriations would allow, the articles which do not deteriorate in store, and especially all articles of special manufacture which can not be readily bought in open market. The lists of material for each harbor should be

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separate, and in a parallel column to the amount required should be placed the amount on hand, and in a third column could be placed the amount yet to be provided. These lists could easily be revised from time to time, as new purchases are made or material expended. The exact condition of the supplies for each harbor would be ascertainable at a glance. The operations of the engineer depot would thus become, in a measure, independent of persons, and a change in the commanding officer could be made even during the period of the most active war preparations without detriment to the service. The duty of the commanding officer of the engineer depot should begin with the preparation of the lists of material required for each harbor and end with the delivery of the material at the harbor in question. The duties of the officer selected to conduct the defense would commence with the receipt of the material at his station.

III. Each important harbor should have at all times its officer for the torpedo defense. His selection need not be made public, if it be deemed impolitic to do so. He would be informed that in the event of a war within a certain period, say five years, he would be depended on to conduct the torpedo defense. Copies of the plans of the Board and of the lists of material prepared by the commanding officer of the engineer depot would be furnished him, and he would be kept informed, from time to time, of any changes therein. He should be informed as fully as possible of the *condition* of the material in store. He would be given facilities for studying all the details of the localities, channels, currents, etc., in which he would be required to operate. This could be done in addition to and without materially interfering with his other duties. He would thus acquire a thorough familiarity with his duties, and upon the outbreak of war, on the receipt of orders to actively defend his harbor, he would approach the problem with the conciousness of being master of it in all its details and of his ability to make the most effective use of the material supplied to him. Every difficulty that is likely to arise will have been considered and provided for, and every provision made to insure dispatch, regularity, and precision in the operations of the defense.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

The POST ADJUTANT.

Table of resistances (in ohms) of the mines of Experimental Grand Group as determined by the winter tests.

[The value given for each week is the mean of the daily tests of that week. Groups 1 and 4 have only two mines each.]

Week ending—	Triple group number.						
	1.	2.	3.	4.	5.	6.	7.
November 21, 1887. (Just after planting groups.)	2,120	1,390	1,429	2,236	1,460	1,400	1,090
December 16, 1887	487	1,157	1,367	479	1,355	1,335	1,089
December 23, 1887	234	884	1,390	130	1,368	1,368	718
December 30, 1887	240	718	1,402	104	1,312	1,387	856
January 6, 1888	111	205	1,425	80	1,198	1,395	828
January 13, 1888	248	476	1,434	235	1,264	1,278	910
January 20, 1888	290	90	1,395	10	1,367	1,357	835
January 27, 1888	143	97	1,395	57	1,394	1,407	374
February 3, 1888	275	165	1,390	30	1,350	1,365	30
February 10, 1888	120	74	1,415	40	1,370	1,414	39
February 17, 1888	340	106	1,400	62	1,400	1,408	46
February 24, 1888	530	10	1,327	28	1,377	1,385	31
March 2, 1888	436	11	963	36	1,357	1,342	79
March 9, 1888	438	9.4	848	45	1,385	1,364	224
March 16, 1888	586	22	919	62	1,387	1,349	338
March 23, 1888	434	47	675	139	1,376	1,376	242
March 30, 1888	471	14	477	47	1,390	1,390	97
April 6, 1888	470	20	115	20	1,360	1,360	70
April 13, 1888	414	18	120	23	1,370	1,246	81
April 21, 1888	238	12	135	18	1,068	1,358	51
Resistance of group with switch-box cut out	1,490	30	211	2,054	.....	.....	683

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2.

TORPEDO DEPARTMENT,
Willets Point, New York Harbor, July 16, 1888.

SIR: I have the honor to report the following tests of Henley's ozokerite multiple cable, purchase of 1883.

The purchase included 9 miles of cable, or 18 drums.

One drum has been used in drills and experiments; the remaining 17 are stored in casemate No. 2.

The records do not show that any previous tests of them have been made.

For convenience in making and recording the tests, the drums in the casemate have been numbered from 1 to 17. To facilitate an inspection of the cables the number of each drum and its tests have been recorded on a small piece of board nailed to the drum.

At the beginning of the tests, the usual method with Thomson's reflecting galvanometer being found inapplicable, it was discovered, in attempting to number the opposite ends of the cores for the purpose of applying the fault test, that the resistance of the insulation between the cores, wet or dry, was so low as to give an appreciable deflection on the service detector. The tests were therefore made without placing the cables in the tanks. The method used was that of measuring the resistance of a conductor with a bridge rheostat and Sieman's galvanometer for balancing. Battery used, 6-cell Leclanche testing battery. One of the cores was taken at random, and the resistances between it and others were successively measured. Both ends of each drum were uncovered and the cores separated so as to avoid contact between the copper conductors.

Description.	Insulation resistance between cores (dry).	Ohms.
	Between—	
Drum 1.—Cores numbered and tagged from 1 to 7. One lead was attached to core 1 and the other to cores 2 to 7 in succession.	1 and 2	564
	1 and 3	587
	1 and 4	694
	1 and 5	519
	1 and 6	547
	1 and 7	520
Drum 1 (continued).—Lead wires then transferred to the other end of the cable, the cores being numbered to correspond with the numbers at the first end.	1 and 2	573
	1 and 3	580
	1 and 4	680
	1 and 5	517
	1 and 6	550
	1 and 7	517
Drum 1 (continued).—One lead then attached to core 1 and the other lead to cores 2 to 7 in succession at the other end of cable.	1 and 2	585
	1 and 3	609
	1 and 4	690
	1 and 5	510
	1 and 6	550
	1 and 7	514
Drum 2.—Outer end of cable.	1 and 2	400
	1 and 3	320
	1 and 4	349
	1 and 5	420
	1 and 6	350
	1 and 7	340
Drum 3.—Outer end of cable.	1 and 2	1,470
	1 and 3	1,240
	1 and 4	1,350
	1 and 5	1,370
	1 and 6	1,440
	1 and 7	1,300
Drum 4.—Inner end of cable.	1 and 2	470
	1 and 3	472
	1 and 4	1,290
	1 and 5	472
	1 and 6	510
	1 and 7	517
Drum 5.—Outer end of cable.	1 and 2	834
	1 and 3	630
	1 and 4	900
	1 and 5	949
	1 and 6	737
	1 and 7	827

Description.	Insulation resistance between cores (dry).	Ohms.
	Between—	
Drum 6.—Outer end of cable.	1 and 2	664
	1 and 3	1,184
	1 and 4	780
	1 and 5	780
	1 and 6	817
	1 and 7	864
Drum 7	1 and 2	740
	1 and 3	1,670
	1 and 4	717
	1 and 5	790
	1 and 6	770
	1 and 7	784
Drum 8	1 and 2	613
	1 and 3	680
	1 and 4	644
	1 and 5	810
	1 and 6	710*
	1 and 7	869
Drum 9	1 and 2	910
	1 and 3	620
	1 and 4	670
	1 and 5	500
	1 and 6	650
	1 and 7	684
Drum 10	1 and 2	557
	1 and 3	527
	1 and 4	517
	1 and 5	550
	1 and 6*	700
	1 and 7	530
Drum 11	1 and 2*	750
	1 and 3	700
	1 and 4	740
	1 and 5	730
	1 and 6	770
	1 and 7	790
Drum 12	1 and 2*	1,230
	1 and 3	600
	1 and 4	640
	1 and 5	640
	1 and 6	620
	1 and 7	630

* Center core.

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Description.	Insulation resistance between cores (dry.)	Ohms.	Description.	Insulation resistance between cores (dry.)	Ohms.
Drum 18	*Between—*		Drum 16	*Between—*	
	2 and 6*.....	1,390		1 and 2*.....	690
	2 and 1.....	770		1 and 3.....	770
	2 and 3.....	710		1 and 4.....	1,070
	2 and 4.....	700		1 and 5.....	740
	2 and 5.....	780		1 and 6.....	630
	2 and 7.....	730		1 and 7.....	780
Drum 14	2 and 1*.....	810	Drum 17	1 and 2.....	1,250
	2 and 3.....	590		1 and 3.....	1,260
	2 and 4.....	530		1 and 4.....	1,230
	2 and 5.....	570		1 and 5.....	1,300
	2 and 6.....	540		1 and 6.....	1,240
	2 and 7.....	590		1 and 7.....	1,330
Drum 15	2 and 1*.....	1,190			
	2 and 3.....	740			
	2 and 4.....	650			
	2 and 5.....	690			
	2 and 6.....	710			
	2 and 7.....	700			

*Center core.

It is recommended that the above lot of cable be submitted to the action of an inspector.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

THE POST ADJUTANT.

(3.)

WILLETS POINT, NEW YORK HARBOR,
July 17, 1888.

SIR: I have the honor to submit the following list of cables whose insulation resistances have fallen below one-tenth of a megohm per mile at 75° Fahr. It is recommended that they be submitted to the action of an inspector.

Ten drums or 5 miles Silvertown multiple, purchase of 1874. Drum numbers and tests are as follows:

Drum No. 893: Date of test, October 25, 1877; observer, General Abbot. Rang numbers freely, *i. e.*, totally bad.

Drum No. 904: Date of test, October 25, 1877; observer, General Abbot. Rang bell freely.

Drum No. 965: Date of test, October 29, 1886; observer, Lieutenant Hale. Highest resistance of any core, 3,060 ohms per mile; lowest, 780 ohms.

Drum No. 985: Date of test, December 21, 1877; observer, General Abbot. Defects 42° with all cores on. No wetting since October 26, 1877.

Drum No. 1024: Date of test, August 2, 1876; observer, General Abbot. Resistance of cores from 9,000 to 30,000 ohms.

Drum No. 1025: Date of test, October 30, 1875; observer, General Abbot. Insulation resistance varied from .05 to .11 megohms.

Drum No. 1026: Date of test, June 2, 1886; observer, Lieutenant Langfitt. Insulation resistance of cores per mile at 75° Fahr., 7,212 to 12,588 ohms.

Drum No. 1035: Date of test, November 9, 1886; observer, Lieutenant Hale. Insulation resistance per mile at 75° varied from 20 to 325 ohms.

Drum No. 1043: Date of test, August 2, 1876; observer, General Abbot. Resistance (mean) of cores, about 3,000 ohms.

Drum number washed off: Date of test, not known; observer, Captain Knight. Highest resistance of any core, 2,240 ohms.

Henley ozonite, purchase of 1883. One drum or one-half mile.

No. 18: Insulation resistance so low as to give a sensible deflection on service detector.

Four drums or 8 miles Silvertown single conductor cable, purchase of 1874. Drum numbers and tests are as follows:

Drum No. 151: Date of test, April 24, 1888; observer, Captain Roessler. Insulation resistance (rough), 5,540 ohms.

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Drum No. 153: Date of test, April 26, 1888; observer, Captain Roessler. Insulation resistance, 31,338 ohms at 41° Fahr.

Drum No. 164: Date of test, November 9, 1886; observer, Lieutenant Hale. Insulation resistance, 9,500 ohms per mile at 75° Fahr.

Drum No. 192: Date of test, October 26, 1877; observer, General Abbot. Insulation resistance, 6,000 ohms.

Siemen's single conductor, sample mile, one drum, purchase of 1874: Date of test, October 19, 1874; observer, General Abbot. Insulation resistance, 11,422 ohms.

To the above list should be added the 17 drums of Henley's ozokerite multiple cable which I reported upon in my letter of the 16th instant.

This letter should form an appendix to my letter of the 16th.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

The POST ADJUTANT.

APPENDIX E.—REPORT OF LIEUTENANT IRVING HALE, CORPS OF ENGINEERS.

WILLETS POINT, NEW YORK HARBOR,
July 7, 1888.

SIR: I have the honor to submit the following report of work in the photographic laboratory during the year ending June 30, 1888.

During February, March, and April, 1888, each of the five second-year officers took a four weeks' course in photography. During the time devoted to the regular winter course of study (December 6, 1887, to April 29, 1888), two non-commissioned officers were detailed each week for instruction in map-printing, and in addition were given as much instruction and practice in the other branches of the subject as the time permitted. During the greater part of the year three non-commissioned officers (Sergeant Wunder, Company A; Sergeant Helling, Company B; Corporal Burtner, Company C) alternated on duty in the laboratory, and received instruction and practice in all branches of the subject, with a view to the selection of a successor to Sergeant Von Sothen at the end of his enlistment, which expires in August, 1888.

The officers' course comprised the subjects laid down in Post Orders No. 233, 1887, and also as much practice as the limited time permitted, with the "American film" negative and bromide paper, which will probably play an important part in military photography in the future, inasmuch as the film negatives can be carried in a roll in the camera, admitting of two dozen exposures without removing roll, and the bromide paper enables prints to be made very rapidly at night by the light of a lamp, rendering the operator independent of daylight.

In previous years the course in photography has covered two seasons, and consisted of four weeks in each of the first and second years, these weeks not, however, being consecutive. The reduction of the course to one season is an improvement, and the making of the work continuous is a great advantage, and is, in fact, essential to good results, but it was found that four weeks is a little too short a time to accomplish the work laid out. Every officer was obliged to spend at least one additional week at the laboratory, and some more, to do the work presented in the order. If photolithography were omitted, the time would be reduced by one or two weeks, but as the making of a good map negative requires considerable skill and practice, and involves different operations from the ordinary negative, and as an officer ought to understand the transfer to the stone and printing, even though he may not expect to have occasion to do this work himself, it would not seem advisable to omit this part of the course if it can be avoided.

In view of these facts, the following recommendations are submitted:

First. That the course consist of at least five, and if practicable of six weeks, and that these weeks be consecutive.

Second. That not more than two officers be allowed to work at the laboratory at the same time, and if the class is small enough it would be better to have only one officer on the duty at a time. It is impossible for a person to do good work unless he can keep apparatus and chemicals in perfect order, know just what each bottle contains and how many times the solution has been used, and in general have entire control over all the material, and this can not be done when two or more are working with the same things; moreover, with two or three officers and as many non-commissioned officers in the laboratory at a time, and all wanting, almost continually, instruction or assistance or material, the sergeant in charge is unable to do justice to his work.

Third. That considerable attention be given to the making of film negatives and the use of bromide paper.

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Fourth. That more instruction be given than heretofore in the use of the alkaline developer; this developer is only mentioned in the text-book, but since the latter was written the alkaline developer has grown much in favor with photographers, and when skillfully handled possesses advantages over the oxalate developer.

During the past few years considerable progress and numerous changes have been made in photographic practice, notably in the perfection of the film negative and rapid-printing bromide paper and in the introduction of the new developers.

I have therefore directed Sergeant Von Sothen to prepare a paper on these subjects, giving also any other changes or improvements that have been made since the text-book was written.

This will be forwarded when completed.

Respectfully submitted.

IRVING HALE,
First Lieutenant of Engineers, Instructor in Military Photography, U. S. Engineer School.

The ADJUTANT,
Post of Willets Point.

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RIVERS AND HARBORS, ETC.

APPENDIX A.

IMPROVEMENTS OF RIVERS AND HARBORS IN THE STATES OF MAINE AND NEW HAMPSHIRE.

REPORT OF LIEUTENANT-COLONEL JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Lubec Channel, Maine.
2. Moose-a-bec Bar, Maine.
3. Narraguagus River, Maine.
4. Bangor Harbor and Penobscot River, Maine.
5. Belfast Harbor, Maine.
6. Rockland Harbor, Maine.
7. Portland Harbor, Maine.
8. Channel in Back Cove, Portland, Maine.
9. Breakwater at mouth of Saco River, Maine.
10. Saco River, Maine.
11. Kennebunk River, Maine.
12. York Harbor, Maine.
13. Portsmouth Harbor, New Hampshire.
14. Cocheco River, New Hampshire.
15. Harbor of Refuge, at Little Harbor, New Hampshire.

EXAMINATIONS AND SURVEYS.

16. Bayoduce [Bagaduce] River, Maine, between the towns of Penobscot and Brooksville.
17. Camden Harbor, Maine.
18. Rockport Harbor, Maine.
19. Kennebec River, Maine, at Bath, and from Augusta to lower end of Perkin's Island.
20. Penobscot River, Maine, from Bangor to Bucksport Narrows.

UNITED STATES ENGINEER OFFICE,
Portland, Me., July 9, 1888.

SIR: I forward herewith annual reports for river and harbor works in my charge for fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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A 1.

IMPROVEMENT OF LUBEC CHANNEL, MAINE.

At the beginning of the fiscal year the contractors, Messrs. Moore & Wright, were engaged upon the work of widening the channel by dredging.

About the middle of August work under the contract was completed, the amount being limited by the available funds.

Under this contract 24,172 cubic yards of material were removed in the fiscal year, making a total of 25,153 under the entire contract.

As a result the widening has been completed for about one-half the length of the channel from the south or Quoddy Roads end.

There remains to be dredged to complete the widening of channel to 275 feet, and to 300 feet in the bends, about 45,000 cubic yards, at an estimated cost of 50 cents per cubic yard, including all contingent expenses.

The following remarks in the Annual Report of 1886 are considered worthy of repetition here:

While the channel now gives a depth of 12 feet at mean low water, the variations are so great that a minimum depth of 8 feet occurs at extreme low tides. No vessel can pass through drawing the extreme depth of water, and in such rapid currents as here obtain in a narrow channel even the best steamers must have 2 or more feet of water under their keels to permit their handling with safety.

The benefits to navigation and to commerce from the improvement are not local. The channel forms a part of a thoroughfare to and from the St. Croix River and the waters of the Passamaquoddy Bay, and is not only the shortest route and the only channel not exposed to the open sea, but is the only one in American waters through which vessels can reach many points on our eastern border.

During heavy gales many vessels find refuge and anchorage in the lower part of Quoddy Roads; in such cases when the wind changes to the eastward there is no longer any protection and no escape, save by the Lubec Channel, which must afford a sufficient draught of water at all times to make it effective. Before the improvement was undertaken many vessels were thus hemmed in and wrecked. (See Report of Chief of Engineers, 1879, Appendix A, page 281.)

Save for use in the fisheries, the smaller vessels are gradually disappearing from the coast, as they can not compete in the carrying of freights with vessels of larger capacity so that deeper channels will be required in future than those heretofore necessary.

The recommendations previously made to dredge the channel to a depth of 15 feet are therefore renewed.

This work will not be injured by a few years' delay, and it would, in my opinion, be better to leave it until a sufficient appropriation to do the work effectively can be made in one sum.

Lubec is in the collection district of Passamaquoddy. The nearest port of entry is Eastport, Me. The nearest light-house in the United States is on West Quoddy Head, about 4 miles below.

There is a Canadian light-house on Mulholland's Point, at the narrows opposite Lubec.

The channel is a thoroughfare to various points on our eastern coast, as well as a factor of safety for the anchorage in Quoddy Roads when the wind changes to easterly points. Local statistics are, therefore, very incomplete, and there is no means of ascertaining the exact number of passing vessels. In 1882 a record was kept of about 10,000 vessels passing Quoddy Head-light-house. No subsequent record has been kept. A record of vessels seen to pass the life-saving station at Lubec in 1887, in day-time and clear weather, shows the number to be 8,683.

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The following appropriations have been made for improving Lubec Channel.

By act of March 3, 1879	$44,000.00
By act of June 14, 1880	20,000.00
By act of March 3, 1881	45,000.00
By act of August 2, 1882	20,000.00
By act of July 5, 1884	10,000.00
By act of August 5, 1886	10,000.00
Total	149,000.00
Expenditures to June 30, 1887	139,932.04
Expenditures in last fiscal year	9,057.93
Total expenditures to June 30, 1888	148,989.97

It is proposed to expend such funds as may be available for the ensuing year in widening the channel, so that it shall have a clear width of 275 feet, and 25 feet additional at the bends. After this is completed, it is recommended that any additional amounts which may be appropriated shall be expended in deepening the channel to 15 feet in accordance with the project of 1884.

The additional cost of deepening the channel to 15 feet is estimated at $135,000.

Money statement.

July 1, 1887, amount available	$9,067.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,057.93
July 1, 1888, balance available	10.03
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	20,010.03
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR 1887.

Number of steam-boat lines at Eastport	4
Arrivals of steam-boats at Eastport	1,000
Arrivals of sailing vessels at Eastport and Lubec	650
Greatest draught of vessels ..... feet	16
Number of vessels owned at Eastport and Lubec	252
Tonnage	25,722

EXPORTS OF EASTPORT, LUBEC, AND CALAIS.

Sardines ..... cases	350,000
Smoked herring ..... boxes	1,000,000
Pickled herring ..... barrels	12,000
Potatoes ..... do	25,000
Lumber ..... feet	40,000,000
Dry fish ..... quintals	11,650
Fresh fish ..... pounds	20,250,000

IMPORTS.

Coal ..... tons	55,600
Lime ..... casks	7,350
Corn ..... bushels	273,000
Kerosine oil ..... barrels	38,000

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Iron	tons..	373
Plaster	do..	13,000
Flour	barrels..	93,000
Sardine oil	do....	7,000
Tin and pig-lead	tons..	7,000
Tin-plate	do..	13,560
Coke for sardine factories	do..	800

The following commercial statistics for the Passamaquoddy district for the fiscal year ending June 30, 1888, were received from the collector of customs:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	761	197,762
Clearances for foreign ports	841	205,519

Amount of revenue collected	$93,315
Value of importations	886,809
Value of exportations	645,277

A 2.

IMPROVEMENT OF MOOSE-A-BEC BAR, MAINE.

This bar, at the eastern terminus of Moose-a-bec Reach, is near the town of Jonesport, Me., about 30 miles east of Mount Desert. The "Reach" is a thoroughfare of about 12 miles in length, which is traversed by thousands of vessels annually; in addition to this it forms an admirable harbor of refuge, and is used as such by many vessels, especially in the winter months.

The project for improving the channel contemplated dredging the bar to a depth of 14 feet and width of 200 feet, and removing the rock known as "Steam-boat Ledge" to a depth of 15 feet at mean low water. The estimated cost of the improvement as amended was $40,000. The dredging then projected was completed in 1885.

The following appropriations have been made for this work:

March 3, 1881	$10,000.00
August 2, 1882	10,000.00
July 5, 1884	10,000.00
August 5, 1886	10,000.00
Total	40,000.00
Expenditures to June 30, 1888	31,841.77

The balance now available is sufficient to complete the improvement as originally planned.

In August, 1887, a contract was concluded for removing the rock from "Steam-boat Ledge" to a depth of 15 feet at mean low water. It was near the 1st of September before the necessary formalities could be completed, and the time was therefore insufficient to complete the work before the autumn months, when it could not be done without great expense and exposure. Only about 50 cubic yards were removed.

The contract has therefore been extended to September 29, 1888, at which time it is expected the present project will be completed.

Moose-a-bec Reach having the bar at its eastern extremity is a thoroughfare for thousands of sail-vessels and many steamers annually. The reach is nearly straight and is thoroughly protected from the sea by islands and shoals, so that it is very much used as a harbor of refuge.

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It is earnestly desired by the owners and masters of vessels navigating the thoroughfare that the channel over the bar be increased to 300 feet in width, and that the small ledges in the reach be removed. The ledges should be removed to a depth of not less than 16 feet. The work completed and the additional work desired are shown upon map opposite page 534, Annual Report of Chief of Engineers for 1886.

The estimate for this work is repeated from last Annual Report, deducting amount of ledge to be removed under present contract:

Removing 3,064 cubic yards of ledge, at $22	$67,408
Widening channel to 300 feet, 65,000 cubic yards, scow measurement, at 35 cents	22,750
Constructing small breakwater to divert cross-currents	6,000
Contingencies, about 10 per cent	8,842
	105,000

The work can not be done with economy on very small appropriations.

The improvement is in the collection district of Machias, Me. The nearest port of entry is Machias, Me. The nearest light-house is Moose Peak.

With the available means it has been found impossible to obtain exact statistics for this work. The commerce of the nearest town is small, but the amount of commerce benefited by the improvement is very large and bears little or no relation to the merely local wants.

Moose-a-bec Reach is a thoroughfare for a large number of vessels and steamers plying between the Dominion of Canada and ports in the United States, and does not depend for its usefulness upon any local commerce. It is estimated that the number of vessels using this thoroughfare and receiving benefit from the improvements is as great as twenty-five thousand annually. Before this improvement was made the route was used by comparatively few vessels.

Money statement.

July 1, 1887, amount available		$9,606.89
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$569.81	
July 1, 1888, outstanding liabilities	879.85	
July 1, 1888, amount covered by existing contracts	1,621.00	
		3,069.66
July 1, 1888, balance available		6,537.23
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		21,537.23

Abstract of proposals for removing ledge from Moose-a-bec Bar, Maine, received July 23, 1887.

No.	Names and address of bidders.	Price per cubic yard measured in place.
1	George W. Townsend, Boston, Mass.	$24.83
2	John F. Hamilton, Portland, Me	26.00
3	Louis E. Lunt, Portland, Me.	16.20

A contract was made with Louis E. Lunt, of Portland, Me., August 12, 1887.

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COMMERCIAL STATISTICS.

The following commercial statistics for the Machias district for the fiscal year ending June 30, 1888, were furnished by the collector of customs:

Shipping.	Number.	Tonnage.
Vessels arrived from foreign ports	19	2,279
Vessels cleared for foreign ports	196	31,341
Vessels built in the district	2	74
Amount of revenue collected		$155.87
Value of importations		3,329.75
Value of exportations		43,330.50

A 3.

IMPROVEMENT OF NARRAGUAGUS RIVER, MAINE.

At the beginning of the fiscal year a contract was outstanding with Messrs. Moore & Wright, of Portland, Me., for commencing the improvement of this channel by dredging.

Work under the contract was commenced on the 16th of August and completed October 10. There were removed from the channel and dumped in deep water outside, 55,450 cubic yards of material measured in scows.

The result is a practicable channel 11 feet deep and 5,000 feet long to the lower steam-boat wharf, the width being 50 feet on the bottom for about 3,600 feet from deep water and the remainder 75 feet wide on the bottom.

This is already a great improvement to the navigation, but as it is not wide enough to permit steam-boats to turn within its limits, it is but little used by large steamers, which therefore wait outside and are lightered of their freight and passengers by a small steamer which runs to the wharf in town.

As soon as the channel can be widened so that the steamers may turn, much delay and expense will be avoided.

The town of Millbridge, at the head of the present navigation, is a shipping point to and from a considerable section of country which has no other convenient connection with commercial points.

The mouth of the river, in addition to its facilities for navigation, is used as a refuge and anchorage for steamers and other vessels in storms; the completion of the channel will therefore add an element of safety as well as convenience.

Previous to June 30, 1887, no expenditures had been made for this improvement save in necessary preparatory work, costing $257. During the last fiscal year there has been expended $9,743; total expenditure, $10,000. The total expense of the work thus far has been approximately 18⅛ cents per cubic yard. The amount (estimated) required to complete the improvement is $40,000.

The improvement is in the collection district of Machias. The nearest port of entry is Machias. The nearest light-house is Narraguagus light-house on Pond Island.

The steamers of the Portland, Bangor and Machias Steam-boat Company touch at Millbridge four times each week. Other irregular lines touch at the same place.

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Money statement.

July 1, 1887, amount available	$9,743.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,743.00
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of steamers		185
Arrivals and departures of sailing vessels		350
Number of vessels owned in Millbridge		50
Tonnage	tons..	3,000
Number of vessels now building		5
Average tonnage	tons..	200
Receipts:		
Stock for manufacture of canned goods, and supplies, and general merchandise for consumption of 5,000 people.		
Exports:		
Lumber	feet..	5,000,000
Canned goods	cases..	29,000
Eggs	do...	3,000

A 4.

IMPROVEMENT OF BANGOR HARBOR AND PENOBSCOT RIVER, MAINE.

The project heretofore adopted for improving the Penobscot River contemplates widening the channel in the harbor of Bangor so as to give a width of not less than 300 feet and a depth of 11 feet at extreme low water, and to increase the width at Crosby's Narrows, 3½ miles below.

The cost of the work was originally estimated at $75,000.

The following appropriations have been made for the work:

By act of July 5, 1884	$20,000.00
By act of August 5, 1886	15,000.00
Total	35,000.00
Expenditures to June 30, 1888	24,795.07

As a result, the channel between Bangor and Brewer has been widened an average amount of 100 feet, giving at least 300 feet in full width, with a depth of 11 feet for a distance of about 2,750 feet.

At the beginning of the fiscal year a contract had been made with Messrs. Moore and Wright for dredging and removing large rocks, to continue the widening of channel.

The contractors were very dilatory in commencing the work, urging various reasons for delay, none of which were satisfactory to this office. The contract had, however, been taken at exceptionally low rates for that location, and if it were to be annulled no practical gain to the work would result either in time or price. It seemed an object to avoid possible litigation and trouble so long as a prospect remained that the work would ultimately be completed. The contract has therefore been twice extended, the last time to October 15, 1888.

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The entire amount accomplished under the contract until June 30, 1888, consisted in dredging 14,102 cubic yards and removing 9$\frac{10}{27}$ cubic yards of large stone from the channel.

The contract will probably be completed on or before the date to which it has been extended.

The amount estimated to complete the improvement as projected is $40,000, and it would result in great economy to the work if it could be made available in a single sum.

The funds available for the ensuing year and the appropriation asked for year ending June 30, 1890, are to be expended in pushing the improvement toward completion, as indicated.

Under the requirements of the river and harbor act of August 5, 1886, a survey of the river between Bangor and Bucksport Narrows was made in the autumn of 1887. A report and estimate for the improvements which are considered necessary to accomplish what is required was submitted January 11, 1888, and was printed in Ex. Doc. No. 133, House of Representatives, Fiftieth Congress, first session. A copy of this report is appended hereto.

Should the work be authorized by Congress, annual appropriations as great as $50,000 are recommended, in order that the improvement may be prosecuted with economy and dispatch.

The commerce of the Penobscot River is very large. The navigable part of the river reaches the interior of the State at a very central and important point, where it touches the line of railroad which connects the United States with the provinces of New Brunswick and Nova Scotia.

Bangor, near which the improvements are located, is a port of entry. Fort Knox the nearest fort, is at the narrows, opposite Bucksport.

Money statement.

July 1, 1887, amount available		$14,596.03
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,868.35	
July 1, 1888, outstanding liabilities	522.75	
July 1, 1888, amount covered by existing contracts	9,822.92	
		14,214.02
July 1, 1888, balance available		382.01
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		50,382.01
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

COMMERCIAL STATISTICS.

The following commercial statistics for the fiscal year ending June 30, 1888, were furnished by the collector of customs for the Bangor district:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	17	3,166
Clearances for foreign ports	37	14,013
Vessels built (steamers)	1	203.21

Amount of duties collected on imports	$147,103
Value of dutiable importations	446,825
Value of free importations	456,975
Value of exportations	149,367

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A 5.

IMPROVEMENT OF BELFAST HARBOR, MAINE.

A small balance of former appropriations remains to the credit of this improvement, but the amount has not been sufficient to materially affect the condition of the harbor, so that no work has been undertaken.

The following-named appropriations have been made for this improvement:

August 14, 1676	$5,000.00
June 18, 1878	12,000.00
March 3, 1879	5,000.00
June 14, 1880	3,000.00
Total	25,000.00
Expenditures to June 30, 1887	22,193.20
Expenditures last fiscal year	20.64

Upon the request of Hon. S. L. Milliken, M. C., representing a necessity for further improvement of Belfast Harbor, the Chief of Engineers directed that an examination be made and a report, with estimate, submitted.

The officer in charge made a personal examination, supplemented by careful inquiries. A report was submitted, of which the following is a copy:

UNITED STATES ENGINEER OFFICE,
Portland, Me., February 2, 1888.

SIR: In compliance with instructions from the Chief of Engineers in indorsement of January 16, 1888, upon letter of Hon. S. L. Milliken, I have the honor to submit the following report regarding the necessity for further improvement in the harbor of Belfast, Me., and an estimate of cost.

The harbor is situated on the west shore of Penobscot Bay and near its northern extremity. I forward in a separate package a tracing from the map of the harbor to accompany and explain this report.

The harbor lies entirely within the town of Belfast, though the principal part of the city proper is on the southwest side. The place has between 5,000 and 6,000 inhabitants and is the natural shipping and receiving point for the surrounding country within about 20 miles.

Some years ago the harbor was improved by dredging to the depth of 12 feet and 10 feet in front of the principal wharves. The improvement was completed in 1879, leaving a small balance of funds still available.

Recommendations have been submitted in the annual reports for 1886 and 1887 that the available balance should be used to deepen the water on the northeast side, but the amount is too small to accomplish much save when taken in connection with additional funds.

On Tuesday of this week, January 31, I was in Belfast and as far as possible ascertained the conditions which seemed to require a greater depth of water.

Belfast is the terminal point of a branch line of the Maine Central Railroad, and the harbor is therefore used in bringing in and carrying out coal and other freights which are distributed or delivered by rail. I am assured by the railroad officials that the depth of water is sufficient for all purposes at present required by them. So far as I can ascertain, the prospect of an ocean terminus for any extensive railroad system at Belfast is not at all promising; in fact I did not find anybody at Belfast who even mentioned the subject; upon inquiry of persons who are interested in the railroads of the State, they intimated that such a result was not probable.

It is my judgment, therefore, that this contingency may be safely left to be provided for when the occasion arises.

The channel in the upper portion of the harbor is quite deep, giving more than 20 feet to a point above Lewis's Wharf; at the wharf, however, the depth is somewhat less.

Heavily-loaded sailing vessels sometimes enter the harbor drawing as much as 18 feet, but the majority of the vessels draw much less.

The channel which passes through the middle of the harbor and leads to the upper wharves affords a clear depth of a little more than 13 feet at mean low water, which is probably as great as can be obtained close to the wharves.

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The slight delay of the large sailing vessels which might be compelled to wait a short time for the tide would not in any way affect the rates of freight or insurance.

The regular steamers between Boston and Bangor which touch at Belfast rarely draw more than 10 feet, and their landing is in a part of the harbor improved previous to 1880.

Another line of steamers running to New York has been making its landings at Lewis's Wharf, and inquiry developed the fact that the steamers of this line had sometimes been delayed by getting aground while going to or from the wharf.

The agent at Belfast informed me that the New York steamers draw from 10 to 11 feet of water, the latter depth being only when heavily loaded.

As nearly as I could ascertain by inquiry the steamer was aground where the map shows but 10 feet of water, though the pilot doubtless thought he was in the channel.

The channel is not marked by any buoys, and in the absence of ranges or definite marks to locate the course it is very difficult to take a vessel up the harbor in the deepest water.

Had the channel been twice as deep the steamer would have gone aground just the same, because it was not in the right place.

I can not resist the conclusion that the main channel in the harbor is deep enough for all present requirements, but it should be buoyed so that vessels can find it.

It would be an excellent plan to establish upon the bridge and the high land a short distance above beacons, to form a range in day-time marking the axis of the channel.

It is possible that the channel may have filled slightly since the last survey, but the character of the inflowing streams is such that any perceptible diminution of depth in ten years is hardly probable.

It would be well to take a few soundings next summer to determine this point with certainty.

There is another feature of this harbor which seems worthy of attention.

Some of the purest ice in the country is harvested in the small stream flowing into the harbor opposite to the Boston steamer's wharf, and that side of the harbor has also other commercial interests.

The large vessels which bring in coal and other freights generally leave without a return freight because the water on the northeast side is not deep enough to permit them to load the ice.

The ice, of which a large quantity is annually shipped, must therefore be either lightered or shipped in small vessels at a higher rate of freight.

The incoming freights are also greater than they would be if the vessels could carry freight in both directions. This is a valuable industry which would be increased with better facilities.

The harbor room for turning the steamers, save at extreme low water, and for anchorage of small vessels at all times, would be much improved by making a depth of 8 feet on the northeast side of the harbor, as shown on the map. This would also permit the shipment of ice in large vessels, and would affect the rates of freight in both directions. I therefore recommend that this be done.

The statistics for this harbor have been difficult to obtain, and they are very incomplete. As far as received they were embodied in my annual report for year ending June 30, 1887.

The estimate for improvement here recommended is as follows:

Dredging 52,000 cubic yards, situ measurement, at 30 cents	$15,600
Deduct probable balance available	2,750
Amount required	12,850

If this amount be made available in one sum the work can be completed in a single season at the minimum of expense, otherwise it is probable that the estimate should be increased.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

It is recommended that $13,000 be appropriated for the additional improvements described.

The harbor is in the collection district of Belfast. The nearest port of entry is Belfast. The nearest light-houses are Dice's Head, Castine, Fort Point, Mouth of Penobscot River, Gilkey's Harbor, and Penobscot Bay, almost equally distant.

Lines of steamers to New York and Boston touch regularly at Belfast throughout the year. Boston steamers make two landings per day, New

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York steamers make two landings per week throughout the year. Other smaller steamers make four landings per day in the summer.

Money statement.

July 1, 1887, amount available	$2,806.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20.64
July 1, 1888, balance available	2,786.16

COMMERCIAL STATISTICS.

Arrivals and departures of vessels	1,250
Foreign arrivals	5
Foreign clearances	16
Vessels built during the year	1
Tonnage....tons..	643

EXPORTS.

Hay	tons..	11,000
Granite (rough and finished)	do...	14,000
Ice	do...	15,000
General merchandise	do...	25,000
Sheep skins and leather	do...	400
Leather board	do...	175
Manufactured clothing	do...	200
Shoes	cases..	15,000
Potatoes	bushels..	48,000
Apples	bbls..	11,000
Eggs	doz..	800,000
Bricks		200,000
Doors, frames, sash and blinds, manufactured from lumber	feet..	1,200,000

Large amount of horses, cattle, sheep, lambs, poultry, and dressed meats, shipped by steam-boats.

IMPORTS.

Grain	bushels..	370,000
Flour	bbls..	14,500
Fish	do...	2,000
Fish	tons..	700
Coal	do...	14,000
Iron	do...	5,000
Nails and hardware	do...	15,000
Merchandise	do...	170,000
Machinery	do...	2,500
Iron water-pipes	do...	11,000
Drain-pipes	do...	300
Paper stock for leather boards	do...	200
Hides and leather	do...	600
Sheeps-skins, to be tanned	do...	300
Grindstones	do...	15
Phosphates	do...	500
Lime and plaster	casks..	17,000
Salt	bushels..	20,000
Lumber	feet..	4,000,000
Lath		1,000,000
Shingles		1,800,000

The foregoing statistics have been kindly furnished by Mr. H. E. Peirce, of Belfast, and are given as a close approximation only.

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The following statistics for the Belfast district for the fiscal year ending June 30, 1888, were furnished by the collector of customs:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	119	9,044
Clearances for foreign ports	129	12,641
Vessels built in the district	3	3,065

Amount of revenue collected	$1,255.88
Value of importations	14,324.00
Value of exportations	33,505.00

A 6.

IMPROVEMENT OF THE HARBOR AT ROCKLAND, MAINE.

The project for improving this harbor, adopted in 1881 and revised in 1882, consists in constructing a breakwater 1,900 feet long from Jameson's Point, and a second breakwater, detached, with a length of 2,640 feet. See map opposite page 464, Report of Chief of Engineers, 1881.

It has been found necessary to raise the first breakwater to the level of mean high water, instead of to 5 feet above mean low water as originally planned.

June 30, 1887, the first breakwater had been practically finished as originally planned.

A contract was then outstanding with Messrs. Hamilton & Soule for delivering stone upon the breakwater to raise it to the level of high water as far as funds permitted.

The delivery of stone was continued until the middle of December, when the weather became so severe that operations were suspended.

The balance of funds on hand being very small the contract was considered as completed.

The amount of stone delivered from July 1 to December 15, was 17,823 tons.

The breakwater was raised to high-water level a distance of 271 feet from the outer end, and was given a width of 20 feet on top.

The stone beacon was taken down and re-erected upon the outer end of the breakwater.

The beacon is now marked by a light at night maintained under the direction of the Light-House Board.

The result of the increased height is to prevent the sea from breaking over to a sufficient extent to cause a sea and undertow inside the breakwater. It is therefore proposed to continue the increase in height as far towards the land as it may be found necessary to produce the result required.

The entire estimated cost of the improvement as now being carried on was $650,000.

The following appropriations have been made for this work:

Act of June 14, 1880	$20,000.00
Act of August 2, 1882	40,000.00
Act of July 4, 1884	40,000.00
Act of August 5, 1886	22,500.00
Total	122,500.00
Total expended to June 30, 1888	120,316.40

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Funds which may be appropriated for the ensuing year will be expended in giving the increased section to the breakwater.

The appropriation asked for year ending June 30, 1890, is to be applied to continuing the construction of the breakwaters in accordance with the approved plans.

It has been urged by parties interested in the navigation and commerce of the place that instead of separating the breakwaters the second should be made as an extension of the first. No recommendations are however, at present made, it being left for future consideration.

Rockland is a port of considerable commercial importance, and its harbor forms an excellent refuge, for which it is largely used.

Local statistics indicate but a small part of the benefits received.

The harbor of Rockland is a port of delivery in the collection district of Waldoborough, of which Waldoborough is the nearest port of entry. The nearest light-house is Owl's Head, 2 miles distant.

Money statement.

July 1, 1887, amount available	$16,868.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	14,684.84
July 1, 1888, balance available	2,183.40
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	32,183.40
Amount (estimated) required for completion of existing project	497,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following commercial statistics for the district of Waldoborough for the fiscal year ending June 30, 1888, are furnished by the collector:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	662	49,540
Clearances for foreign ports	691	55,077
No record is kept of arrivals and departures coastwise.		
Vessels built in the district	5	2,439

Arrivals and departures of steamers at port of Rockland, upwards of fifty weekly.	
Revenue collected (duties)	$1,227.58
Importations mainly Canadian and non-dutiable.	
Value of importations	75,287.00
Value of exportations	651.00

A 7.

IMPROVEMENT OF THE HARBOR AT PORTLAND, MAINE.

The project adopted in 1886 for this improvement consists in dredging a channel 500 feet wide and 29 feet deep at mean low water from deep water of the outer channel to the front where the largest steamers receive and discharge their cargoes. The plan is indicated upon a map opposite page 450, Report of Chief of Engineers for 1887.

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The estimated cost of dredging the channel above-described was $135,000.

In a harbor like that of Portland small points occasionally require attention which have not been definitely outlined in reports previously submitted to Congress. A letter has been recently received from the agent of the International Steam-ship Company asking that a small shoal near the steamers' landing may be removed. An examination of the place will be made as soon as practicable, and such recommendation will be made as the case may seem to require.

For the project indicated there has been appropriated the following amount:

By act of August 5, 1886	$30,000

At the beginning of the fiscal year dredging was in progress under a contract with the National Dredging Company, of Wilmington, Del.

Work under the contract was completed December 28, 1887. Much of the material had been harder than was anticipated, and a large part of it was of such a kind that the most tedious part of the work was to dump the material from scows after it had been dredged. Notwithstanding the difficulty the contractor pushed the work forward vigorously and to the entire satisfaction of this office.

The amount of material removed under the contract was 198,872 cubic yards, measured in situ.

The entire expenditure during the fiscal year has been $27,951.75.

The total expenditure upon the project has been $29,992.34.

As a result, the portion of the new channel lying along the front of the wharves an average length of about 1,600 feet and width of 400 feet has been deepened from 21 feet to 29 feet depth at mean low water in addition to the slopes on the outer edges of the cuts.

The improvements thus far are only partial, as the new channel does not yet extend outside, but it permits the movement of the largest vessels about the wharves at all stages.

The prices obtained were exceptionally low. It is not prudent to estimate the cost of completing the improvement otherwise than by deducting the amount appropriated from the amount of original estimate.

This leaves the balance estimated to complete the deep channel $105,000.

It would result in great advantage to the work if this amount could be made available in a single sum.

Portland is the most important port east of Boston both in a commercial and military point of view.

The harbor is defended by Forts Preble, Gorges, Scammel, and a battery at Portland Head.

There is a light-house on the breakwater, and a second at Portland Head, 3 miles distant from the city.

The harbor is in the collection district of Portland and Falmouth, Maine, of which Portland is the port of entry.

Money statement.

July 1, 1887, amount available	$27,959.41
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	27,951.75
July 1, 1888, balance available	7.66
Amount appropriated by act of August 11, 1888	40,000.00
Amount available for fiscal year ending June 30, 1889	40,007.66

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Amount (estimated) required for completion of existing project	$65,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	65,000,00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals of sailing vessels	2,885	Lines of steamers, foreign and coastwise	11
Arrivals of steamers	736		

IMPORTS.

By transatlantic steamers (85,000 tons)	$6,905,716	Value of other imports by water	$1,751,318

PRINCIPAL ARTICLES IMPORTED IN SAILING VESSELS.

Molasses, 24,425 hogsheads	$739,875	Coal, 400,000 tons	
Sugar, 29,090,000 pounds	1,360,000		

LANDED ON THE WHARVES OF BACK COVE.

Coal	tons	3,000	Building brick	tons	1,000
Pipe-clay	do	8,000	Granite	do	2,000
Fire-brick	do	1,000	Castings	do	1,300

EXPORTS.

Value of exports by sea		$4,503,061	Oats	bushels	49,750
By ocean steamers	tons	100,000	Peas	do	522,290
Wheat	bushels	1,272,910			

The following statistics for the fiscal year ending June 30, 1888, are furnished by the collector of customs:

Shipping.	Number.	Tonnage.
Arrivals from foreign ports	291	89,543
Clearances for foreign ports	412	142,567
Vessels built within the district	3	219

Amount of revenue collected	$509,332
Value of importations	2,292,875
Value of exportations	3,152,441

A 8.

IMPROVEMENT OF CHANNEL IN BACK COVE, PORTLAND, MAINE.

The project for this improvement, adopted in 1886, consists in deepening and straightening the channel so that it shall have a depth of not less than 12 feet at mean low water and a width of 300 feet, following the harbor commissioner's line.

A map is submitted, to accompany this report, showing the location as finally adopted and the progress made to June 30, 1887.

The original estimated expense of the improvement was $181,000. A trifling modification in the original location has slightly reduced the amount of material to be removed, so that the revised estimate is $180,000.

By act of August 5, 1886, there was appropriated for the work the sum of $26,250.

At the beginning of the last fiscal year the necessary surveys and maps and other preliminary work had been completed and a contract had been made for dredging as far as the available funds will permit.

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The last annual report explained the reasons for delay in entering upon the contract.

Dredging was commenced August 29, 1887, and continued until December 14, when work was suspended for the winter.

On the application of the contractor the time of completion of the contract has been extended, first to June 30, 1888, and subsequently to September 30, 1888.

The entire amount of material taken from areas which have been dredged to grade has been 49,602 cubic yards, situ measurement.

In addition to this, a considerable portion of adjacent cut has been removed, but is not included in reports nor payments, as the contract requires completion to grade before payments can be made.

As a result a part of the channel, over 2,000 feet long and 72 feet wide, has been dredged to give a least depth of 12 feet at mean low water, and an additional distance of 930 feet has been dredged to the same depth, with a width of 24 feet.

The funds now available of the first appropriation are expected to cover expense of completing the first three cuts from the point of starting to the end of the channel, as shown upon the map.

The amount expended in the fiscal year is $9,281.02.

Total expended to June 30, 1888, $10,728.39.

The progress made by the contractor thus far has not been satisfactory, though there have been many causes of delay, which the contractor could not foresee nor prevent. His requests for extension of time have therefore been approved in this office, and the extension has been authorized by the Chief of Engineers.

The completion of the channel is expected to add to the convenience of receiving and shipping large amounts of coal, lumber, potter's clay, and miscellaneous articles, and it will cause greatly reduced freights, especially in the interest of suburban villages, towards which the growth of the city is tending.

With the appropriations which may be made available for the purpose, it is proposed to continue the improvement by completing the first cuts the entire length, and then to widen the channel by successive cuts until the entire width is obtained.

Back Cove is a part of Portland Harbor, and is therefore in the same collection district, and is defended by the same forts, and is near the same light-houses as are given for Portland Harbor.

The commercial statistics can not at present be separated from those of the principal harbor, with which they are therefore included.

Money statement.

July 1, 1887, amount available		$24,802.63
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,880.35	
July 1, 1888, outstanding liabilities	2,400.67	
July 1, 1888, amount covered by existing contracts	14,950.00	
		24,231.02
July 1, 1888, balance available		571.61
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		25,571.61
Amount (estimated) required for completion of existing project		128,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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A 9.

BREAKWATER AT MOUTH OF SACO RIVER, MAINE.

The present project for this improvement consists in repairing and completing the old breakwater so that it shall have a height of 15 feet above low water and a width of 12 feet on top. It has been recommended that after completing the work thus far the breakwater be extended to Sharp's Ledge.

The following appropriations have been made for the work:

By act of July 5, 1884	$15,000.00
By act of August 5, 1886	12,500.00
Total	27,500.00
Total expenditure to June 30, 1887	20,024.04

At the beginning of the fiscal year work was in progress under a contract with George Willett Andrews, of Biddeford, Me., for placing stone upon the breakwater and rectifying the beacon.

Work under the contract was completed October 6, 1887. The amount of stone delivered in the fiscal year was 6,484 tons, and the entire amount under the contract was 10,964 tons.

The beacon has been placed in an erect position, and has been secured by heavy stone placed at the end of the breakwater.

A length of 1,310 feet of the breakwater has been completed from the outer end, and an additional distance of 292 feet has been made nearly ready to receive the capping stones.

In the first year after commencing the work the amount of stone required to complete a given length was largely in excess of the estimate, owing to displacement and sinking in the sand. It was therefore thought necessary to increase the estimate submitted in reports for 1886 and 1887. The stone delivered under the last contract has, however, gone further than was expected, so that the average for the whole work done is about the same as the original estimate.

The estimated amount required to complete the old breakwater is therefore the original estimate reduced by the amount appropriated. Balance required June 30, 1888, $42,500.

Any funds which may be made available for the ensuing year will be applied to the completion of the breakwater.

It is recommended that the amount necessary to complete the old breakwater be appropriated for fiscal year ending June 30, 1890.

The Saco River Breakwater is a part of the work for improving Saco River, Maine; but its completion will not benefit the bar at mouth of the river to any appreciable extent until other work for improving the river can be constructed on the opposite side of the channel, as recommended in the last annual report for Saco River.

The breakwater is in the collection district of Saco. The nearest port of entry is Saco. The nearest light-house is Wood Island light-station.

Commercial statistics are included with those for Saco River.

Money statement.

July 1, 1887, amount available	$7,475.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	7,474.48
July 1, 1888, balance available	1.48
Amount appropriated by act of August 11, 1888	12,500.00
Amount available for fiscal year ending June 30, 1889	12,501.48
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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A 10.

IMPROVEMENT OF SACO RIVER, MAINE.

The project for improving the Saco River was adopted in 1886, its object being to obtain a depth of 6 feet at mean low water to the cities of Saco and Biddeford.

The points requiring improvement to obtain the results indicated were the following:

The bar at the mouth of the river.

Ledge and shoals at Little Islands (the latter requiring one or more submerged jetties).

Shoal from Pier 2 to wharves.

Closing channel between Cow Island and mainland.

See Report of Chief of Engineers, 1884, page 484, and 1886, page 555.

At the beginning of the fiscal year contracts had been made with Thomas Symonds, of Leominster, Mass., for removing the ledge at Little Islands, and with Robert Hamilton, of Chebeague, Me., to dredge the shoals near the same place.

The removal of the ledge was commenced in September, 1887, and was completed November 18. Two hundred and fourteen cubic yards of rock were removed from the ledge, so that the channel between the islands has been given a width of 110 feet, with a depth of 6 feet at mean low water.

The dredging of the adjacent shoals was commenced August 29, and was completed October 31. The amount of material removed from the channel by dredging was 19,407½ cubic yards, measured in scow.

As a result there is a good channel of 6 feet depth at low water, though somewhat crooked, past Little Islands, the width—save at the point between the islands, where it is narrow—being 200 feet or more.

A further work, consisting of a stone jetty and training-wall, will be required to concentrate and direct the flow so that the channel may be maintained by the scour of the current.

Upon the representation of parties in Saco and Biddeford that dredging near the coal wharves was greatly needed, authority was received from the Chief of Engineers to expend a balance of $4,000 for that purpose.

The work was commenced November 1 and was completed December 5 by Mr. Robert Hamilton, who had dredged the shoal at Little Islands. As the time did not permit of making a formal contract after public advertisement, and it was not probable that any advantage would be obtained even had there been time, Mr. Hamilton was employed to do the work at the same price as on the other work for which he had been the lowest bidder.

The amount of material removed under this agreement was 16,987 cubic yards, and it resulted in giving a clear channel along the front of the wharves to the full depth of 6 feet at mean low water. The average width dredged was 100 feet, and the average length 750 feet. This gave a great temporary relief to the shipping interests of the place, which would otherwise have been greatly embarrassed in receiving coal and other articles before the closing of the river by ice.

Observations have been made to obtain the direction and velocity of the current in the ordinary tides near Little Islands, and these have been extended to the time of freshets over the principal places where improvements are required except over the bar at the mouth.

The changes which occur in the channel are almost exclusively due to the scouring action and the deposition of drift at times of freshets.

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The only appropriation thus far made for this improvement was by act of August 5, 1886, $12,500.

Amount expended to June 30, 1888, $12,436.32.

The work considered necessary to give the required depth was originally planned to consist largely of dredging.

It is believed, however, that a channel dredged in the broader places of the sandy bottom will not remain for any great length of time unless the current be restricted to a width which is found sufficient to maintain a good depth in the narrower parts of the river. It is also considered desirable to construct the works for contracting the space in which the current flows before doing any dredging, as it is probable that by this means the scour will reduce the amount of material to be otherwise removed.

The general features of a project for this purpose were indicated in last Annual Report (pages 457 and 458, Report of Chief of Engineers, 1887), and a map and plans of the work were quite fully shown. It is probable that certain details of the plan may require modification, but the principle employed is considered so essential to the maintenance of a good channel that the project is recommended, and the estimate is here repeated:

Jetty at mouth of river, 65,000 tons stone, at $1	$65,000
Improvement at Little Islands	15,000
For pier-head, coal-wharf channel	10,000
Revetment to coal-wharf channel	4,500
For wing dams, 20,000 tons stone, at $1	20,000
Revetment of shoal, 2,500 tons, at $1	2,500
Dredging channel	10,000
Contingencies of engineering, etc	13,000
Total	140,000

The bar at the mouth of the river is the most serious obstacle to the navigation.

The depth over the bar frequently changes, but it is much of the time as small as the depth over the shoals above.

Vessels which arrive off the bar at low stages of water must wait outside in all kinds of weather, until high water, and even then large vessels are likely to have difficulty in passing.

The breakwater, for which a separate appropriation is made, and which is therefore made the subject of a separate report, is filling its office fairly well, but it merely prevents, to a greater or less degree, the drifting of sand across the mouth of the river, and can not confine the current so as to maintain a channel of good depth.

It is therefore recommended as of prime importance that works for producing and maintaining a good channel over the bar should be undertaken as soon as the funds therefor may permit.

The estimate for completion of present project does not include the removal of the bar at the mouth of the river.

Saco River is in the collection district of Saco, Me., of which Saco is the port of entry. Nearest light-house, Wood Island.

Money statement.

July 1, 1887, amount available	$11,935.24
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11,871.56
July 1, 1888, balance available	63.68
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,063.68

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Amount (estimated) required for completion of existing project	$40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

STATISTICS.

The following commercial statistics for the fiscal year ending June 30, 1888, were furnished by the collector of customs:

Number of clearances for foreign ports	4
Tonnage	596

A 11.

IMPROVEMENT OF KENNEBUNK RIVER, MAINE.

No appropriation has been made for this work since 1881.

Improvements at the mouth of the river were begun in 1798 by the State of Massachusetts with the approval of Congress.

The work subsequently built has consisted of crib-work, forming a jetty and protection near the mouth of the river, a wooden pier or wharf about 1,000 feet above the mouth, and two granite piers or jetties across the bar at the mouth of the river. The channel has also been dredged, and two small ledges of rock have been removed to give a depth of 4 feet at mean low water.

The appropriations for the work have been—

By act of March 2, 1829	$5,000
By act of March 2, 1831	1,175
By act of July 3, 1832	1,700
By act of June 28, 1834	10,300
By act of July 2, 1836	7,500
By act of March 3, 1837	3,000
By act of July 7, 1838	8,000
By act of August 30, 1852	7,500
By act of July 11, 1870	5,000
By act of March 3, 1871	5,000
By act of August 14, 1876	5,000
By act of March 3, 1879	2,000
By act of June 14, 1880	2,000
By act of March 3, 1881	2,000
Total	65,175

On the 30th of June, 1887, there remained on hand a balance of $336.34.

The improvements have maintained a good channel over the bar and to the bridge and wharves, about $1\frac{3}{4}$ miles above.

In the month of June, 1888, the top of the wooden pier was repaired and re-covered with gravel.

No other work has been done, and no work is proposed for the ensuing year, save such minor repairs as may be paid for by the small remaining balance.

The river is in the collection district of Kennebunk; nearest port of entry is Kennebunk; nearest light-house is on Goat Island, near Cape Porpoise.

Money statement.

July 1, 1887, amount available	$336.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	236.92
July 1, 1888, balance available	99.42

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COMMERCIAL STATISTICS.

The following commercial statistics for the fiscal year ending June 30, 1888, were furnished by the collector of customs:

Arrivals and departures coastwise	75
Vessels built in the district	3
Tonnage	75

A 12.

IMPROVEMENT OF THE HARBOR AT YORK, MAINE.

The project for this work consists in widening the channel in three places to obtain a depth of 10 feet at mean low water, with room for the movement of vessels.

There has been appropriated for this improvement the following amount:

By act of August 5, 1886	$15,000.00
Total expenditures to June 30, 1888	12,928.11

At the end of the fiscal year work was progressing under a contract for removing gravel and rock from the point at Stage Neck, and from the second point above, at prices of 65 cents and 35 cents per cubic yard, respectively.

Work was continued until August 26, when there had been removed 4,059 cubic yards in situ from the upper shoal, and 15,283 cubic yards from Stage Neck Point.

At the latter place numerous borings had previously been made to ascertain the kind of material to be removed. Nothing worse than coarse rocks and gravel had been discovered.

In dredging it was discovered that a considerable point of ledge projected into the part to be removed at the point of Stage Neck. This is the important part of the entire improvement, and it was therefore thought best to suspend further operations until the ledge can be removed.

A careful survey of the ledge, which had been exposed by dredging, was made in November, 1887, and the quantities to be removed were ascertained.

The project can not be completed and no benefit can obtain from the channel from the work already done at that place until the ledge is removed. This makes it necessary to revise the original estimate for the entire work as follows:

903 cubic yards of ledge, at $15	$13,545.0
21,167 cubic yards of gravel and rock, at 65 cents	13,758.55
36,168 cubic yards of sand and gravel, at 35 cents	12,658.80
Contingencies of engineering, etc	4,037.65
Total for depth of 10 feet	44,000.00

In this narrow part of the channel the tidal current is exceedingly strong, and but for the rock it would no doubt scour the place to a greater width and depth.

The proportion of vessels carrying coal, ice, and other freights which draw more than 10 feet is very large, and a jagged bottom at that depth is very dangerous. If the rock is to be removed at all, I am of the opinion that a depth of 12 feet at mean low water is the minimum which

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is advisable. This will increase the quantity of ledge to be removed to 1,700 cubic yards, and will add $13,500 to the estimated expense.

As the original project only contemplated a depth of 10 feet the estimate for completion of project is for 10 feet only.

York Harbor is in the collection district of York, Me., of which York is the port of entry. The nearest light-house is at Cape Neddick.

Money statement.

July 1, 1887, amount available	$14,319.35
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	12,247.46
July 1, 1888, balance available	2,071.89
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	12,071.89
Amount (estimated) required for completion of existing project	19,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	19,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

A 13.

IMPROVEMENT OF PORTSMOUTH HARBOR, NEW HAMPSHIRE.

The project for improving this harbor comprises the following:

(1) Constructing a breakwater across the side channel between Great Island and Goat Island. This was completed in 1880, but has since been re-inforced by receiving the stone excavated from Gangway Rock.

(2) Removing Gangway Rock to a depth of 20 feet at mean low water. The depth was restricted to 20 feet, owing to the expense attending a greater depth.

(3) Removing to 10 feet depth at mean low water the ledge on the point at Badger's Island.

The original estimate of cost submitted in 1879 was $150,000.

The following appropriations have been made for the work, viz:

By act of March 3, 1879	$10,000.00
By act of June 14, 1880	25,000.00
By act of March 3, 1881	20,000.00
By act of August 2, 1882	17,000.00
By act of July 5, 1884	20,000.00
By act of August 5, 1886	15,000.00
Total	107,000.00
Total expended to June 30, 1888	106,604.94

At the beginning of the fiscal year work was in progress under a contract with Mr. George W. Townsend, of Boston, Mass., for completing the removal of Gangway Rock.

The time for completing the contract was November 30, 1887, but work was somewhat delayed by unavoidable causes, so that an extension to June 30, 1888, was asked by the contractor and was authorized by the Chief of Engineers.

The work was, however, pushed forward with all possible rapidity, even into the extreme cold of winter, and was finished January 11, 1888.

The amount of ledge removed was 632 cubic yards, all of which has

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been deposited upon the breakwater between Great Island and Goat Island, to give it additional thickness and stability.

This completes the removal of Gangway Rock, and completes all the improvements originally projected, except a portion of the ledge projecting from the point of Badger's Island.

The amount of ledge remaining to be removed is 590 cubic yards. The average of four bids for removing the first part of this ledge was $34.59¼ per yard; but prices are now somewhat lower, and the estimate may safely be made as follows:

590 cubic yards ledge, at $30	$17,700
Contingencies of engineering and superintendence	2,300
	20,000

The rock is very hard and is exposed to very rapid tidal currents, both flood and ebb, and is upon the slope of the point, so that its removal is expensive. The cross-section through which the current flows will be so little increased by the removal, being but a little more than 1 per cent., that it is not probable that any perceptible effect to the tidal currents will result. On the other hand, the proposed depth of 10 feet over the point is less than the draught of a large proportion of the vessels which pass. The currents are peculiar in their action at this place, and at low water they run nearly as rapidly as at any other stage. Vessels will be more likely to be driven near or over the point after the ledge is removed than before, so that the liability of injury by striking the ledge is increased rather than diminished by the removal.

It is therefore recommended that no further work be done unless it be considered desirable to remove the rock to a depth of not less than 18 feet.

The expense of removing the point ledge to 18 feet depth to the same line which limits the former project is as follows, the price per yard being estimated lower than for the 10-feet depth because it can be done cheaper:

3,442 cubic yards submerged ledge, at $25	$86,050
Contingencies, 10 per cent	8,605
Total	94,655

For such an expenditure the area of the cross-section of the river at low water would be increased but a trifle over 4 per cent. on the side where the currents are least rapid.

The point is in a bend of the river, and the most rapid currents are on the opposite side. It is hardly possible that these strong currents can be radically affected by the removal of the ledge even to 18 feet, as indicated, so that, although I consider it decidedly better than the smaller depth, I do not recommend any further work at present, because the benefits are not commensurate with the expense.

Money statement.

July 1, 1887, amount available	$12,269.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	11,874.58
July 1, 1888, balance available	395.06
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,395.06

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Amount (estimated) required for completion of existing project	$5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Number of arrivals of sailing vessels	805
Number of arrivals of steamers	42

IMPORTS.

Coal	tons..	237,000	Lumber	feet..	62,902,000
Railroad-ties		141,049	Laths		70,000
Cement	barrels..	36,000	Lime	barrels..	34,000
Salt	boxes..	10,000	Plaster	do....	5,000
Salt	hogsheads..	1,000	Molding-sand	tons..	1,300
Iron	tons..	750	Ashes	do....	100
Potatoes	bushels..	3,722	Phosphates	do....	800
Oysters	do....	1,875	Stone	do....	500
Wood	cords..	150	Concrete	do....	100
Miscellaneous merchandise				tons..	1,650

EXPORTS.

Brick	15,000,000

Number of steam-boat lines	4
Number of tug-boat lines	4
Number of irregular tow-boats arriving for tows	50
Number of vessels owned	63
Tonnage	10,198.87

The above statistics have been courteously furnished by Col. William H. Sise, president of the Portsmouth Board of Trade.

A 14.

IMPROVEMENT OF THE COCHECO RIVER, NEW HAMPSHIRE.

A full description of this river, and its connection with the Piscataqua, was submitted in the last Annual Report. The present project for improving the Cocheco River contemplates cutting a channel through the ledge and other material a short distance below the city of Dover, N. H., so as to give a width of 50 feet, and depth of 5 feet at low water. For the same purpose bowlders are to be removed from the channel below the narrows. The original estimate for cost of this improvement was $47,000.

The following appropriations have been made for this work, viz:

By act of July 5, 1884	$28,000.00
By act of August 5, 1886	10,000.00
Total	38,000.00
Total expended to June 30, 1888	37.682.11

At the date of the last Annual Report a contract was outstanding with Mr. Thomas Symonds, of Leominster, Mass., for removing ledge and bowlders from the channel.

Work under the contract was completed September 30, 1887; 738 cubic yards of solid ledge and 350 cubic yards of bowlders were removed under the terms of the contract.

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The ledge was the worst portion of the obstruction, and the result thus far has been of great benefit to the navigation of the river, and the completion of the project will be a still further benefit.

While a draught of 5 feet at mean low water is of vast benefit to the place, and has made the channel navigable nearly to Dover for vessels of 600 tons, or even more, at extreme high water, yet the time for such navigation is limited to very short intervals near the highest stages.

The narrow channel not being straight, is very difficult to navigate with a tug having large vessels in tow, and the interests involved indicate that it will need to be made both wider and deeper.

The commercial interests of Dover were quite fully given in my report for 1886, to which I refer. (See page 550, Report of Chief of Engineers, 1886.)

Money statement.

July 1, 1887, amount available	$9,502.64
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,184.75
July 1, 1888, balance available	317.89
Amount appropriated by act of August 11, 1888	9,000.00
Amount available for fiscal year ending June 30, 1889	9,317.89

COMMERCIAL STATISTICS FOR 1887.

Arrival of sailing vessels, 90.
Vessels built during the year, 1 sailing vessel, 1 steam tug.

RECEIPTS BY WATER.

Coal	tons	25,000
Lumber	feet	5,000,000
Lime and cement	casks	12,000

A 15.

HARBOR OF REFUGE AT LITTLE HARBOR, NEW HAMPSHIRE.

The project for this improvement, adopted in 1886, was based upon a recommendation by Col. George Thom, Corps of Engineers (Report of Chief of Engineers, 1882, page 507.) It consisted in dredging a channel 100 feet wide and 9 feet deep across the bar a distance approximately 3,000 feet; widening the anchorage basin to 300 feet for a distance of 700 feet, and constructing a small breakwater on the ledge at Jerry's Point. The estimated cost was $33,000.

The object of the work is to make a harbor in which vessels may take refuge at such times as they are unable to make a harbor in the mouth of the Piscataqua River owing to the great rapidity of the ebb tides.

The act of Congress approved August 5, 1886, appropriated $10,000 for this improvement.

Amount expended to June 30, 1888, $9,907.76.

At the beginning of the fiscal year a contract had been made with Messrs. Moore & Wright, of Portland, Me., for dredging in the channel.

Work was commenced early in July and was completed as far as funds permitted on the 22d of September.

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There were removed from the channel 36,021 cubic yards of material, resulting in a cut 75 feet wide and 2,400 feet long, to the depth of 9 feet.

The cut does not reach to the inner anchorage, so that no benefits to navigation are yet obtained.

It will be readily seen that a channel of 3,600 feet long, nearly all of which is but 100 feet wide, and has but 9 feet in depth at mean low water, and but little more than 6 feet at extreme low water, will serve but little purpose for sailing vessels, especially as the winds, at times when it would be needed, would blow across the channel for its entire length, and at low-water stages nothing larger than a small fishing smack could venture to enter.

An enlarged project has therefore been recommended, at an ultimate probable cost of $225,000.

For a description and plan I refer to my last annual report. (See Report of Chief of Engineers, 1887, page 470, with map.)

There are at present no commercial statistics to report for this place save as they have been given in previous reports, giving wrecks, etc., and the statistics for Portsmouth and Dover. All vessels for these points pass Little Harbor.

Money statement.

July 1, 1887, amount available	$9,650.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	9,558.05
July 1, 1888, balance available	92.24
Amount appropriated by act of August 11, 1888	20,000.00
Amount available for fiscal year ending June 30, 1889	20,092.24
Amount that can be profitably expended in fiscal year ending June 30, 1890 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	23,000.00

A. 16.

PRELIMINARY EXAMINATION OF BAYODUCE [BAGADUCE] RIVER, MAINE, BETWEEN THE TOWNS OF PENOBSCOT AND BROOKSVILLE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December —, 1886.

GENERAL: The river and harbor act of August 5, 1886, required an examination or survey of the "Bayoduce River between the towns of Penobscot and Brooksville, Maine."

By letter of September 27, 1886, from office of the Chief of Engineers, the duty was assigned to me.

Coast Survey chart No. 311 of the Penobscot River and Belfast Bay, Maine, and Coast Survey chart Penobscot Bay, Maine, contain very complete maps, though on a small scale, of the river in question. Upon these charts the name of the river is given as "Bagaduce," and I find through inquiry in the locality that the name indicated by the Coast Survey is correct.

* * * * * * *

For maps to explain this report I refer to the charts already mentioned. It will be seen that the Bagaduce River is a tidal water open-

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ing into Penobscot Bay at Castine. The lower part or mouth of the river forms the harbor of Castine, where the mean rise of the tide is 9.3 feet.

About 5 miles above the mouth of the river is a place known as the "narrows," though even here the banks are at least 700 feet apart, and the channel for the largest vessels is more than half that width.

Immediately above the "narrows" the river is much broader and divides into the North and South Forks. The tidal portion of the North Fork terminates in the Northern Bay, while that of the South Fork passes through the "South Bay" and thence in a tortuous channel through various "narrows" and broad places to the town, or rather village, of Brooksville, a distance of about 8 miles. The river between Penobscot and Brooksville consists of the two forks mentioned, a total distance by the channel of about 11 miles.

From the "narrows" to Penobscot the North Fork is broad and has a good channel, though somewhat indirect, as far as Bridge's Point. This point is on the east shore where the river widens into Northern Bay, about 3 miles from the "narrows," and a little more than three-fourths of a mile below the head of the channel at Penobscot.

* * * * * * *

The town has two villages, known, respectively, as "Penobscot" and "South Penobscot." The latter is at the head of the tidal channel of the river on the southeast shore of the bay, while the former is 1 mile further north.

Owing to the very crooked channel in the broad waters of the two forks, and of the very rapid tidal current through the "narrows," there is a great desire expressed to have the shallow places suitably marked by buoys, and it would seem that the necessity is not exaggerated.

Although the question of buoyage does not properly form a part of this report, it is here mentioned for the reason that this examination seems to have been asked by the people, partly to secure the proper marking of the channel, which is one of the greatest needs of the navigation.

Above Bridge's Point, in the Northern Bay, the channel is narrow and at low water has not sufficient depth for even the smaller coasting vessels which carry freights to distant points. Even this small channel is greatly obstructed by points of ledge and by bowlders where it passes between Winslow's Island and the mainland.

The ledge and bowlders mentioned form such an obstruction that vessels are compelled to leave the channel entirely and pass over the flats on the other side of the island; this can only be done at high water and with vessels of comparatively small draught. Any regular or reliable communication by water are, therefore, at present impracticable, though the shipments by water from this point are sufficient to make freights for 210 vessels, many of them so large that they have to be loaded below Bridge's Point, at great additional expense.

At the time of my examination of the river, an order for a large shipment of bricks was received from a sea-port town in Massachusetts, but after a long search no vessel could be found with sufficient size and light draught of water. This is mentioned to illustrate the situation.

To fulfill the requirements, the channel should be straightened and deepened so as to give a width of 150 feet from Bridge's Point to Winslow's Island, and thence a width of 100 feet to the village of South Penobscot, with a depth of 6 feet at low water throughout.

The Coast Survey chart is not sufficiently in detail to furnish the in-

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formation needed for a definite estimate of the expense; it may, however, be approximated very closely, as follows:

Dredging, 90,000 cubic yards, at 25 cents per yard	$22,500
Removing 500 cubic yards of ledge and bowlders, at $10	5,000
Contingent expenses	2,500
Total	30,000

To ascertain whether the present and prospective commerce of the place is such as to make the river worthy of improvements by the General Government, I made careful inquiry and obtained the following statistics and information.

There is an extensive industry of brick-making carried on in Penobscot, which is only awaiting better communication to be very largely increased. A large part of the bricks have to be lightered, and it is difficult to obtain the larger class of vessels for freight, so that the expense is increased about 50 cents per thousand for freight, lighterage, breakage, and delay.

The 50 cents per thousand thus lost represents a large part of the entire profit, so that the production is restricted. About 5,000,000 bricks is the present annual average of manufacture on the North Fork, and a good channel would probably result in doubling that number.

About 2,500 cords of wood are shipped from Penobscot annually; also about 3,000 bushels of potatoes and various other agricultural products.

Winston's Creek, which flows into the Northern Bay at South Penobscot Village, furnishes power for two stave-mills, two single-mills, one saw-mill and lath-mill, and one mill for grinding corn meal. There is also in the village a knitting factory.

All these industries would be enabled to ship their products at reduced prices were the freights by water regular and reliable.

The number of freighting vessels arriving on the North Fork of the Bagaduce annually is given as 210, and about an equal number of yachts and small craft in addition.

There is a fine granite quarry which can not now be operated, owing to cost of transporting stone, which may figure among the prospective business of the place.

Penobscot is the natural outlet of quite a large section of country remote from any direct line of railroad, 10 miles over a hilly road from Castine Harbor, and 14 miles to the nearest point of the branch railroad from Bangor to Bucksport.

A regular line of steamers from points on Penobscot Bay is only awaiting a time when the channel above Bridge's Point shall be improved, to make daily trips to South Penobscot village.

On the south fork of the river the freight vessels arriving are given as numbering ninety, with an equal number of smaller craft. There are 500,000 bricks shipped annually, and the number would be increased were the channel freed from obstruction so that large vessels could be employed. Over 2,000 cords of wood are annually shipped in small vessels of from 30 to 40 tons each.

Navigation on this fork at present extends only a short distance from the South Bay, and its only serious obstacle is in Johnson's Narrows, at which point the channel is very narrow and obstructed by ledges of rock. Some years ago the worst parts of the obstruction were removed by individual enterprise, but still only small vessels can pass, and then only when the water is at a high stage.

In my opinion the character of the Bagaduce River when considered with its present and prospective commercial interests, renders it worthy of improvement by the General Government in the places indicated.

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An approximate estimate of the expense on the north fork is submitted above, but I have no data upon which to estimate the expense of work in Johnson's Narrows. The latter will probably not be large.

I recommend that a survey be made of the places requiring improvement. The expense of such a survey, including the platting and completing of maps and estimates, will be $400.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF BAYODUCE [BAGADUCE] RIVER, MAINE, BETWEEN THE TOWNS OF PENOBSCOT AND BROOKSVILLE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., February 2, 1888.

SIR: I have the honor to submit the following report upon a survey of the Bagaduce River, Maine (incorrectly printed "Bayoduce" in river and harbor act of August 5, 1886).

The instructions and allotment of funds for this and several other surveys were received in a letter from the Chief of Engineers, dated March 16, 1887.

The large amount of work which has been required to complete the surveys, maps, and estimates for several improvements, some of them extensive, has made it impracticable with the small amount of funds which could be allotted for the purpose to submit this report at an earlier day. The map of the survey is still incomplete, though far enough advanced to furnish a basis for the plan of improvement and an estimate of its cost.

A tracing of the map will be forwarded, as soon as completed, to accompany this report. The commercial features of this river were explained in my preliminary report.

I inclose herewith, to form part of this report, the report of Mr. F. S. Burrowes, assistant engineer, to which I invite attention for the details of the survey.

The plan devised for improvement is essentially the same as was outlined in the preliminary report, but it has not been considered necessary to make any part of the channel more than 100 feet wide, so that the quantity to be dredged is somewhat reduced.

On the other hand, the survey indicates that the rock to be removed to make a clear channel, full width, is more than was estimated from mere observation.

The estimate given in Mr. Burrowes's report, $45,000, for this improvement, will doubtless be ample, provided appropriations are large enough to complete the dredging and the broken ledge, each by itself, in a single contract. The removal of the rock is the more important, and it is therefore recommended that the first appropriation should be $25,000, to insure its complete removal in one season, otherwise the expense will be made greater, and but little benefit would result from removing only a part of the rock.

Johnson's Narrows is of less importance than the channel to South Penobscot, and its improvement may properly be left until the other

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work is completed. The estimate in Mr. Burrowes's report ($1,875) covers all that is considered necessary for any immediate requirements in this locality.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
PORTLAND, ME., *February* 1, 1888.

MAJOR: I have the honor to submit the following report upon the survey of the Bagaduce River, Maine, between the towns of Penobscot and Brooksville, made under your direction in August, 1887.

As explained in your preliminary report, the portion of the river between the points named includes two branches, the one through the Northern Bay to South Penobscot, and the other through Johnson's Narrows and Southern Bay to Brooksville.

In accordance with your verbal instructions the survey was restricted to an examination of the channel through Northern Bay, and of Johnson's Narrows. Both surveys have been plotted on one chart to a scale of 1 : 2,000.

An azimuth line carefully measured with a steel tape was run down one shore, the deflection points being marked by drill-holes in the ledge. The soundings were located by intersection with two transits and the depths measured with a graduated rod.

The plane of reference to which the soundings have been referred is that of the lowest tide observed during the survey.

The difference in level between mean high water and mean low water is about 9.5 feet.

A bench-mark was established near wharf at South Penobscot, as shown on the chart, being a drill-hole in large bowlder. It is 19.44 feet above the plane of reference.

A bench-mark was established at Johnson's Narrows, as shown on the chart, being a drill-hole in ledge. It is 14.12 feet above plane of reference.

CHANNEL THROUGH NORTHERN BAY.

The survey of the upper branch included the portion of the channel through Northern Bay from head of tide-water at South Penobscot to Bridge's Point. At present the channel is very narrow, crooked, and shallow, and so obstructed by rock opposite Winslow's Island as to make it hazardous to navigate at all stages of tide, and vessels are compelled to wait for extreme high water so as to be able to pass over the shallower but safer flats to the north of the island.

The plan of improvement upon which the following estimate is based is to obtain by dredging and blasting a nearly straight channel, 100 feet wide and 6 feet deep at low water, from the wharf at South Penobscot to deep water at Bridge's Point, and passing to the south of Winslow's Island, a total distance of 4,000 feet. Most of the material, from an examination made by driving down an iron rod in a number of places, seems to be soft mud and clay, with some gravel, and could be dredged without great difficulty. The loose rock at Winslow's Island could, with proper machinery, be thrown outside of the proposed channel, and only the larger pieces would require blasting.

ESTIMATE.

80,000 cubic yards dredging, at 25 cents	$20,000
3,417 cubic yards rock to be removed, at $6	20,502
Engineering and contingencies	4,498
Total	45,000

JOHNSON'S NARROWS.

The lower or southern channel is contracted at Johnson's Narrows to a low-water width at one point of 150 feet, both banks being ledge. There is an available depth

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of 4.5 feet at low water through the narrows, and no general improvement, such as the widening of the channel by the removal of large quantities of rock, could be obtained except at a cost greatly in excess of the benefits to be derived therefrom.

Two small rocks immediately below the narrowest part, which project 1.50 feet above low water, are so located as to be a source of danger, and their removal would be a benefit to navigation. The following is an estimate of the cost of their removal to a depth of 6 feet below low water:

Removing 125 cubic yards of rock, at $15 ..... $1,875

Your preliminary report shows the commercial importance of a portion at least of this river, and as it is the only outlet except by wagon road for a large section of country, its improvement would be a great benefit.

Before closing this report I wish to acknowledge the willing and intelligent assistance rendered by Mr. William B. Bennett during the past season, both in the field work of the surveys and in the preparation of the maps.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Maj. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 17.

PRELIMINARY EXAMINATION OF CAMDEN HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 18, 1887.

GENERAL: I have the honor to submit the following report of a preliminary examination of Camden Harbor, Maine, in compliance with requirements in the river and harbor act of August 5, 1886, and with instructions received from the Chief of Engineers.

On the 1st and 2d days of December, 1886, I visited Camden, and obtained the following points bearing upon the commercial interests and statistics of the place:

In a walk around the harbor I observed various vessels which were noted as follows: Three large schooners, heavily loaded, one of three masts, were lying at anchor, preparing to depart, and a fourth was already under way; two schooners of fair size and one small one were receiving cargoes at wharves; another was lying idle at the wharf, and a small unloaded schooner was at anchor. Of small fishing vessels, yachts, and other sailing craft of various sizes which were estimated as ranging from 5 tons to 25 tons burden, I counted twenty which had been taken into winter quarters.

Three ship-yards figure among the industries of the place. From one of these a small steamer had been launched the day before my arrival, and another had been launched in October last; in the last year a small yacht was built at the same yard at the head of tide-water in the harbor.

Two of the three ship-yards are more especially adapted and used for building small vessels; a list was, however, furnished me of seven large vessels built at one of these yards in the last eleven years, the average capacity of which was over 500 tons each. The third ship-yard is close by the steamboat wharf, and is one of the very few in the State where ship-building has been continued without interruption. From this yard a four-masted schooner has very recently been launched, having a capacity of 1,165 tons. In the nine last years but one year has

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passed in which no vessels were launched from this yard, and the average has been slightly over two per annum, twenty vessels having been launched in the time mentioned.

The total tonnage of the twenty vessels was 10,177 tons, an average of over 500 tons to each, and only one vessel of the entire list was as small as 350 tons.

Camden is an enterprising village of about 3,000 inhabitants, and is the principal inlet and outlet for freights and passengers by steamer for a considerable section of country. The nearest railroad is at Rockland, about 8 miles distant. Most of the articles which are especially required for the ship-building industry are manufactured at Camden.

Prominent among the manufactories is an establishment for forging anchors, for which about 1,500 tons of iron are brought in annually as crude materials. Other establishments turn out oakum, wood-work, carvings, blocks, capstans, plugs and wedges, pumps, and windlasses; there are also a shop for the manufacture of machinery, a woolen-mill for felts and cloths, a powder mill, a large bakery with water-power, and two grist-mills In addition to productions of these manufactories there are shipped from Camden annually from 50,000 to 60,000 barrels of lime, 150 tons of hay, 25 tons of bran and flour, over 60 tons of meal, and a vast amount of miscellaneous small articles going by the regular steamers, of which it is difficult to obtain definite statistics.

The steamers between Boston and Bangor touch regularly at Camden eight times each week during the year, and during the summer season there are daily steamers each way for between three and four months; these will make nearly five hundred arrivals of steamers annually. The amount of freight received and shipped by these steamers is very large, besides many passengers.

Complete statistics of articles brought to Camden by water could not be obtained, but the following are given as a partial statement:

Corn	bushels..	50,000
Bran and flour	tons..	100
Coal	do...	4,500
Salt	pounds..	125,000
Wood	cords..	2,500

Coal costs from 10 to 15 cents per ton more than would be required with a fair depth of water to near the wharves; and all other shipments and receipts are similarly affected. Add to this the great inconvenience to ship-building, and to steamers in their numerous landings, and the necessity for improvement can not be questioned.

I believe that the facts mentioned fully show that the harbor is worthy of improvement by the General Government.

A survey of Camden Harbor was made in 1872, and two small channels, each 80 feet wide, were subsequently dredged to the upper part of the basin under appropriations made in 1873, 1874, and 1875, $10,000 in each year. The channels were planned for depth of 7 feet at low water, but the work by contract was so imperfectly done that the clear depth throughout did not exceed 6 feet. The channels being narrow and the adjacent banks soft, some filling has since obtained, so that the present depth is entirely inadequate to accommodate vessels of the size necessary to conduct business with fair economy.

The maps in this office are believed to be sufficiently accurate for the purpose of making a plan and estimating approximately the cost of improvement. It will, however, be desirable to ascertain more accurately the present depth of water and the changes which have taken place since the survey of 1872 before the final adoption of any plan.

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The estimated cost of the hydrographic survey and correcting the maps, including transportation, boats, etc., is $300.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF CAMDEN HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 28, 1888.

SIR: In compliance with instructions from the Chief of Engineers, dated March 16, 1887, I have the honor to submit the following report of a survey of Camden Harbor, Maine, with a plan for its improvement and an estimate of the probable expense.

In connection with several other surveys required in the river and harbor act of August 5, 1886, the field work and platting of maps was assigned to Mr. F. S. Burrowes, assistant engineer. For the details of the survey I invite attention to Mr. Burrowes's report which is inclosed herewith.

A comparison of the soundings obtained with those taken in a survey made fifteen years ago shows that any filling which may have taken place in the harbor has been too small to cause any perceptible change in the general depths of water; the channels have probably changed slightly by wash of material from the edges of the middle ground in the upper part of the harbor.

The only method by which greater depths can be obtained is by dredging.

A tracing from a map of the survey is forwarded in a separate package to accompany this report; upon the tracing the areas which should be dredged are fully shown.

The areas to be dredged are as follows:

First. A small area, marked A upon the map, should be deepened to 12 feet at mean low water, that depth being required to enable the regular lines of steamers to effect a landing at all stages of the tide.

Second. The area marked B should be deepened to 10 feet at mean low water, to form the approach to the upper harbor, where most of the business and shipping points are located.

Third. A channel 100 feet wide, marked C, and a second channel 50 feet wide, marked D, should be given the same depth of 10 feet as in the approach.

The small channels marked E, F, and G do not require as great a depth as that further down the harbor, because the vessels from the small ship-yards at the upper end can always be launched at high water, and are, of course, not loaded. The other business in the upper end of the harbor is small, so that a depth of 5 feet at mean low water will be sufficient.

After the portions mentioned have been dredged, it would be advisable to dredge the middle ground to the same depths of 10 and 5 feet as the channels between which it lies. The benefits from this would be, first, the greater permanence of the channels, because they would not be filled by wash from the middle ground, and the slight amount of

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drift from the inflowing streams would be more uniformly distributed over the entire area instead of being principally in the channels.

The second benefit would be the safe anchorage for numerous small vessels and the greater facility of moving to and from the wharves.

The currents in the harbor from tides and streams are not sufficient to be considered as a factor in maintaining the depths.

For measurements in situ the expense, including all contingencies of supervision, etc., is estimated at 35 cents per cubic yard, making the probable expense as follows, viz:

	Cubic yards.
Area A	3,300
Area B	32,400
Channel C	19,700
Channel D	7,700
Channels E, F, and G	10,100
Total measurement	73,200

Expense, at 35 cents per yard, $25,520.

This covers the essential part of the improvement. On its completion, should further appropriations be made they should be applied to removing the middle ground, for which the estimate is as follows:

	Cubic yards.
Area H	74,600
Area I	24,000
Total	98,600

Expense, at 35 cents per yard, $34,410.

The removal of the middle ground, though desirable, is not essential, and it should not be undertaken until the other parts are completed.

It seems proper to add that to make this improvement with any regard to economy the channels and approach covered in the first estimate should be done by contract at a single time.

For small amounts at points distant from commercial centers, competition by contract is nearly, if not entirely, eliminated, so that the prices to be paid are greatly increased, and by prolonging the time the contingent expenses are made much greater.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 27, 1888.

MAJOR: I have the honor to submit the following report upon the survey of Camden Harbor, Maine, made under your direction in September, 1887.

The same methods were adopted as in the survey of Rockport Harbor; that is, a system of triangles was used as the basis of measurement, and topography filled in with the stadia. The depths were measured with a graduated rod and the positions of soundings located by intersection with two transits.

The survey has been plotted on one sheet to a scale of 1: 1000.

The plane of reference to which the soundings are referred is mean low water as established during a survey of the harbor made in 1872.

The bench-mark used was also established during that survey and is 14.86 feet above the plane of reference. It is a drill-hole in ledge, 18 feet southerly from the southeast corner of Adams & Stetson's upper salt store; its location being indicated on the map.

The survey of 1872 was made with a view to an improvement of the harbor, which was afterwards carried out. It consisted in dredging an approach to the harbor and

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channels along the wharves. A careful comparison of the present survey with that of 1872 shows that there has been no appreciable filling on the undisturbed middle ground in the harbor. There has been some slight filling in the dredged channels, caused doubtless by gradual washing in from the sides, and not by the deposition of material brought into the harbor by the small streams flowing into it.

The areas proposed to be dredged in carrying out the project for the further improvement of the harbor are indicated on the chart and lettered from A to I.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Maj. JARED A. SMITH.
Corps of Engineers, U. S. A.

A 18.

PRELIMINARY EXAMINATION OF ROCKPORT HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 24, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination of Rockport Harbor, Maine, made in compliance with requirement in the river and harbor act of August 5, 1886, and instructions from the Chief of Engineers.

The earliest opportunity for making this examination was on the 2d of December, on which day I visited the place and obtained such information as seemed necessary for the purpose of this report.

Rockport Harbor is on the west shore of Penobscot Bay and about 6 miles north of Rockland Harbor; it is at the northern extremity of a small bay having a broad entrance on the south, but entirely sheltered from storms in all other directions. The water is quite deep south of the portion in which wharves have been constructed.

For a more full understanding of the situation, I refer to Coast Survey Chart No. 321, harbors of Camden and Rockport, Me., and to Coast Chart No. 4, Penobscot Bay, Maine.

The mean rise of tide is 9.8 feet, and in most places inside the harbor the water is deep enough to meet the ordinary requirements of commerce. There are a few points, however, where some embarrassment is caused by shallow water and bowlders, which could be remedied by a comparatively small amount of work.

So far as I could ascertain, the principal obstruction to the harbor is the rock shown on the chart as Harbor Ledge, upon which there is erected a stone beacon.

The top of the ledge is submerged but about 3 feet at mean low water; it forms a ridge of about 150 feet in length, and a greatest width of about 40 feet, lying obliquely across the west side of the harbor entrance in a northwesterly direction from the beacon.

A large part of the shipments from this harbor are in the winter, and the retention of the ice about the wharves is a most serious obstruction.

The beacon and the ledge hold the ice which gathers in the harbor and prevent its going out with each receding tide, and thus place a serious embargo upon the winter traffic.

It was represented to me that the revenue cutters have frequently assisted vessels, which would otherwise have been unable to move, by breaking the ice in the harbor.

On the day of my visit there were five large and heavily-loaded schooners lying at anchor near the lower wharves waiting for a favora-

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ble wind to depart; two schooners were unloading lumber at one of the wharves; three large unloaded schooners and one small one were at anchor awaiting room at the wharves to take in a shipment; three large schooners were lying at wharves taking in cargoes of lime, and three were discharging cargoes of wood—seventeen vessels, most of them of more than average size, engaged in the business of the place in a single day. In the past year there have been shipped from the harbor of Rockport 300,000 barrels of lime, 40,000 tons of ice, 100,000 cases of fish, clams, and lobsters, besides miscellaneous smaller items for which no statistics were procured. The manufacture and shipment of lime has increased more than one-third in the past two years, and new facilities just introduced for transporting limestone by railroad instead of wagons give promise of a continued increase for some succeeding years.

Close by the village is a large fresh-water pond which furnishes an excellent supply of ice. This industry is one which receives great injury from the insufficient depth and a large bowlder near the wharves, as well as from the difficulties of winter shipments from causes already mentioned.

There is reason to believe that a considerable increase in the ice shipments would result from a removal of the obstructions. Among the heavy articles brought into the harbor are coal and wood; of the latter, there is now an annual consumption of 15,000 cords in the manufacture of lime alone.

Rockport and Camden are among the few places on the coast from which the ship-building interest has not entirely departed. Ship-building has been continued regularly at Rockport, though no vessels have been built there since August, 1885. Since 1882 three vessels of 2,200, 2,400, and 2,600 tons, respectively, have been built and launched in this harbor, and it is expected soon to commence another. From the office of the deputy collector of customs at Rockport, I have been furnished with a list of thirty-nine vessels, owned in that place. The largest of these has a gross tonnage of 2,628.93 tons; three have a tonnage of over 2,000 tons each; eight have over 1,000 tons each, and fourteen have over 600 tons each.

The vessels carrying ice draw from 15 to 18 feet of water, and some of the vessels entering the harbor draw 20 feet.

The deputy collector of customs has also furnished the following information regarding arrivals and departures of vessels:

> From January 1 to December 1, 1886, there were 279 foreign entrances and clearances of vessels which delivered or received their cargoes at said Rockport. * * * I think I am safe in saying that the number of vessels arriving at the port of Rockport will average very close to 100 per month.

It may be observed that the number of foreign vessels is in excess of twenty-five per month, or about one for every working day in the year; and many of the heaviest shipments from the place are made in the winter.

In my opinion the condition and commerce of the harbor of Rockport are such that it is worthy of improvement by the General Government.

The Coast Survey charts, though giving a very good map of the harbor on a small scale, are insufficient in detail to furnish information on which to base an accurate estimate of the expense of necessary improvement.

It is, therefore, recommended that a survey of the harbor be made as soon as it can be done with advantage and economy in the coming spring.

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The expense of such a survey, including the platting of maps and making of plans, is estimated at $350.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF ROCKPORT HARBOR, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 18, 1888.

SIR: I have the honor to submit the following report of a survey of Rockport Harbor, Maine, made in accordance with instructions from the Chief of Engineers, dated March 16, 1887.

The field-work and platting of maps for this survey were put in charge of Mr. F. S. Burrowes, assistant engineer, and the survey was made in connection with several others in such succession as would cause the least loss of time and least distance to travel.

Mr. Burrowes's report, which I inclose herewith as part of my own, furnishes all necessary details of the field and office work. A tracing of the map of the harbor is forwarded in a separate package to accompany this report. In my report of a preliminary examination of this harbor, submitted December 24, 1886, I mentioned such points as I was enabled to ascertain by a personal examination and inquiry.

The statistics then submitted are considered sufficient to show the importance of the harbor and the propriety of its improvement, provided the expense be not incommensurate with the probable benefit.

The difficulties pointed out to me in my preliminary examination were the retention of ice by the "harbor ledge," which greatly increases the difficulty of shipping in winter, and the insufficient depths near the wharves.

Since the map of the survey has been platted I have given the subject a more careful consideration than was possible before. This study has been made by Mr. Burrowes and myself in mutual consultation, and the general conclusions and estimates of cost have been embodied in Mr. Burrowes's report.

There being no reservoirs beyond the harbor to be filled and emptied by flow of tides, there are no tidal currents of sufficient strength to be considered as factors in clearing the harbor of ice.

The harbor proper is very small in area and the land is sufficiently high to protect it from the force of winds which might assist in driving out the ice.

I have reached the conclusion that it is undoubtedly true that the ice is a great injury to the harbor in winter, and that the beacon, standing as it does about midway between the shores near a point which may be fairly called the *harbor entrance*, would naturally be regarded as the cause of the trouble; but that it may not necessarily follow that the removal of the beacon and the ledge upon which it stands will result in the clear water which seems to be expected.

The harbor, being very small and shallow near the wharves, has the water somewhat freshened by the inflow of the small streams, so that the formation of ice during the succession of tides which rise and fall almost without perceptible current will take place between and around the wharves, with lodgments even upon the bottom, so that it is not easy to see what force will operate to remove the ice, protected from wind ex-

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cept on the side which makes it enter the harbor, even were the "harbor ledge" removed.

Should the ledge be removed to a depth barely sufficient to be beyond the reach of "anchor ice," a depth of say 12 feet, it would, in my opinion, become a serious danger to vessels drawing more than that depth of water, for they would be more likely to strike upon the ragged bottom than upon the ledge, which is now smooth and well marked. If removed at all it should therefore be to a depth great enough to clear the keels of large vessels, or say 20 feet. This would require the blasting and removal of 9,800 cubic yards, most of which is solid ledge, at an estimated price, including contingent expenses, of $15 per cubic yard, making a total of $147,000.

The harbor is entirely protected from all winds except from the south, and at such time the removal of the ledge would have a tendency to permit an increase "undertow" near the wharves, from the sea setting into the harbor. This part of the subject may, therefore, be summarized as follows:

(1) There is no certainty nor even strong probability that the removal of the ledge will entirely remedy the evil or very greatly reduce it. The evil of ice in the harbor is one of latitude and longitude combined with its local features, of which the ledge forms but one.

(2) It is not improbable that the removal of the ledge will increase the difficulty of vessels lying at the wharves during southerly storms.

(3) The estimated expense is too large to be recommended without a greater probability of large resulting benefits. The water at the upper end of the harbor is very shallow, so that access to the wharves in that part can only be had at high stages, and even then only by vessels of comparatively small draught.

I believe that an increase of the depth to 12 feet over the small area shown upon the map will result in a very great benefit to the facilities for shipping lime and ice at all times of the year, as well as for shipping and receiving any other articles of freight.

It also seems probable that such increase of depth will decrease the lodgment of ice upon the bottom, and to some small extent make the movement of vessels through the ice in that part of the harbor less difficult.

Should ledges of rock be found to underlie the earthy material above the grade indicated, the expense of their removal would probably not be justified.

The amount of funds which could be allotted to this survey was not sufficient to cover the expense of complete borings; these, however, can be readily made before a contract for dredging is completed.

I recommend that the dredging indicated be done as far as practicable. The estimate of $14,000 for the purpose is included in Mr. Burrowes's report, to which I invite attention.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 16, 1888.

MAJOR: I have the honor to submit the following report upon the survey of Rockport Harbor, Maine, made under your direction during the past summer.

The survey was commenced August 26, 1887, and completed September 1.

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A system of triangles carefully measured and computed was used as the basis of the survey. The triangulation stations were marked either by drill holes in ledge or nails in the wharves. Shore-lines, wharves, buildings, and other adjacent topographical features were located by stadia measurement from triangulation points. The survey was mapped on one chart to a scale of 1:1000, which is herewith submitted.

The soundings were measured with lead and brass sounding-chain, the positions being located by intersection with two transit instruments.

The soundings on the chart are reduced to the plane of mean low water. This plane was established by three comparisons at slackwater with the plane of mean low water at Camden as determined and referred to a bench-mark in 1872 by Mr. A. C. Both, assistant engineer.

A bench-mark was established, being a drill hole in ledge 20 feet east of the southeast corner of Barrett's fish-house. It is 19.90 feet above the assumed plane of mean low water. Its location is indicated on the chart. The difference in level between mean high water and mean low water, as given on the charts of the U. S. Coast and Geodetic Survey, is 9.8 feet.

Rockport Harbor is an arm of Penobscot Bay, and is well protected on all sides except to the southward, in which direction it opens unobstructedly to the bay. Its shores are composed almost entirely of rocks. The entrance to the harbor is very deep, and there is a good channel 36 feet deep as far up as the lower wharves. There is an available depth of 12 feet to within 350 feet of the head of the harbor, and extending over two-thirds of its width.

HARBOR LEDGE.

Almost in mid-harbor, and about 300 feet below the lower wharf, is a rock known as Harbor Ledge, the top of which is but 4.4 feet below mean low water. It is at present marked by a masonry beacon 11.5 feet square and extending 24 feet above mean low water. From its general formation and location it is apparently an upheaval of the same ledge, which juts out from the shore to the northwest of the beacon. As at present marked it can not be regarded as an obstacle to the free entrance of the harbor, as to the east of it there is a straight channel 24 feet deep and 300 feet wide.

It is perhaps a benefit in partially protecting the upper part of the harbor from the heavy seas caused by the winds blowing from the direction in which it is most exposed.

The principal cause of complaint appears to be that the ledge and beacon cause the ice to anchor and jam around them, thus preventing the ice in the upper portion of the harbor from moving out as freely as it otherwise would. If this interference with navigation in the harbor should be regarded as of sufficient importance to justify the removal of the ledge, it should be taken out to a depth of 20 feet at mean low water and back to the general line of the 20-foot curve above and below it, in order to give safe and unobstructed passage to both vessels and ice. To obtain such depth would require the removal of 9,800 cubic yards of material in situ, at least 75 per cent. of which would be solid ledge. To obtain a depth of 18 feet over the same area would require the removal of 6,500 cubic yards in situ of the same material. The beacon on the ledge contains 155 cubic yards of masonry. Its removal, without the removal of the ledge also, would add hazard to navigation by leaving a dangerous obstacle, not definitely marked, close to the channel, without a corresponding benefit, as the ice would still be partially held by the ledge itself.

SHOAL IN UPPER END OF HARBOR.

From the 12-foot curve to the upper wharves the water shoals very rapidly, having an available depth of only 4.25 feet at mean low water along the wharves. This shoaling is presumably caused by the material washed down from the hills by Rockport Brook and another small drain at the head of the harbor. Nothing more, however, than a superficial examination was made of the character of the material, which could only be definitely determined by a thorough set of borings

If the whole upper part of the harbor bounded by the lines of the prominent wharves were dredged to a depth of 12 feet at mean low water an improvement would be obtained which would greatly facilitate the present and cause an increase in the future traffic of the place.

The following estimate gives the amount of material to be removed within the lines and to the depth mentioned. The areas proposed to be dredged are marked on the chart with black shade lines.

A small rock close to the eastern line of the area proposed to be dredged and opposite the upper ice-house should also be removed to a depth of 12 feet.

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ESTIMATE.

Dredging in upper end of harbor, 40,640 cubic yards in situ, at 30 cents	$12,192
Removing small rock opposite upper ice-house, 35 cubic yards in situ, at $20	700
Engineering and contingencies	1,108
Total	14,000

Rockport is a place of considerable commercial importance. It ships annually large amounts of ice and lime. Within the past year a narrow-guage railroad 2 miles long has been constructed, connecting the quarries with the kilns at Rockport. For the detailed commercial statistics of the place I would refer to your report upon the preliminary examination of the harbor.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Maj. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 19.

PRELIMINARY EXAMINATION OF KENNEBEC RIVER, MAINE, AT BATH, AND FROM AUGUSTA TO LOWER END OF PERKIN'S ISLAND.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 27, 1886.

GENERAL: I have the honor to submit the following report of a preliminary examination of the Kennebec River, Maine, at Bath, and from Augusta to lower end of Perkin's Island, in compliance with a requirement in the river and harbor act of August 5, 1886, and instructions received from the Chief of Engineers.

On the 7th of December I visited Bath, and proceeded down the river as far as Perkin's Island on a tug, in company with several pilots and other parties who are acquainted with the river and its commerce.

There are a few points in the river below Bath where small ledges in the river bottom make shallow places in the channel, but as they are marked by buoys and have plenty of water on either hand, they are not considered as obstructions, and do not require any present attention.

"The Coast Survey chart of the Kennebec and Sheepscot rivers, Maine," numbered 314, to which I refer, shows a small island in the river about 3 miles above its mouth, the name on the chart being "Perkin's Island." This is the only island on the river shown on the charts by that name, but as there are at present no improvements required below Bath, and from Augusta to the island in question would include Bath, for which a separate examination is required, I conclude that the limitations were intended to be at Bath, and from Augusta to the south end of the large island near Richmond, upon which the town of Perkins is situated, but which is shown upon the unpublished Coast Survey chart as "Swan Island." Upon such an interpretation this report is submitted.

The obstructions in the river at Bath consist of a few small points of ledge projecting above the general level of the bottom; they are in the channel, but near the wharves, and so situated as to cause much inconvenience and some hazard.

Some of these ledges are of sufficient size to be indicated upon the larger-scale charts of the river at Bath. One of the ledges shown on the chart without a name is now locally known as the "Steam Mill Rock," and is about 600 feet north of the buoy on Trufant's Ledges; a second

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ledge is known as Houghton's Rock, and a third is adjacent to the wharf of the railroad ferry. Apparently the same general line of upheaval is shown at Trufant's Ledges, Lincoln's Ledges, and at Hospital Point.

The last-named ledge seems to be but little in the way of navigation, and will probably require no attention. How far the others may need removal can only be determined after a careful survey; but of the necessity for removing some, if not all, of the ledges mentioned to such a depth that the keels of large vessels can no longer reach them there can be no doubt.

From Bath to the south end of Swan Island (Perkin's Island) there are no obstructions which are at present considered worthy of attention. From this point to the dam at Augusta I went over the large scale charts very carefully with some of the best pilots on the river, and on December 18 I visited Augusta, and by inquiries there and at Hallowell added further points to my information on the subject.

So far as I have been able to ascertain the greatest embarrassment to the river navigation is caused by the narrow channel and shallow water over the rocks in the sharp bend at Lovejoy's Narrows. This place is in the channel east of Swan Island and at the head of Little Swan Island.

I forward, to accompany this report, a tracing, giving an outline sketch, which shows the location of the narrows, and a second sketch on the same sheet indicating on a large scale the parts of ledge which should be removed. The present condition is such that the channel is confined between rough ledges so near to each other that two large vessels have not room to pass each other. The situation is rendered worse because of the bend at this point, which tends to conceal from each other vessels which are approaching from opposite directions. The adjacent land is high and the current is rapid. Most of the vessels are towed up and down the river. Should a tug, going in the direction of the tide or river current with a tow, meet other vessels at this point, it must go ahead at whatever risk of collision or incur the certainty of injury to vessels in tow, which would be driven into the narrows by the force of the tide.

At low water the place is entirely impassable for vessels of any considerable draught.

Some portions of the ledge have been removed at different times under former appropriations for that purpose; the last work being completed in September, 1877.

The work then done gave a narrow channel of but 10 feet at mean low water and 15½ feet at mean high water, of summer stages. (Report of Chief of Engineers, 1878, Part I, page 38.)

Shipping in large vessels has been found so advantageous, that at present the most economical size is only limited by the depth of water in the channel. This is especially true for the shipment of ice, of which an immense amount is annually cut at points above Swan Island. A large part of the vessels now employed in such shipping can only pass these rocky narrows and other shallow points at the high-water stage, so that delay and expense are added to the danger of injury, and much larger vessels could be used with great resulting economy would the depth of water permit.

The surveys heretofore made of Lovejoy's Narrows are sufficient to afford a fair degree of accuracy in the computation of quantities of stone which should be removed. The channel must, of necessity, be limited by the situation, but it should be straightened as far as prac-

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ticable, made sufficiently wide for vessels to meet without special danger, and be as deep as 18 feet. In improving such a channel it is recommended that points of ledge should be removed to a depth below the shallower parts of the river bottom in their vicinity, because a hull resting upon an earthy bottom receives little or no injury, but if it touch the rocks it can not fail to receive damage causing more or less serious results.

I am enabled to submit the following estimate of improving the channel at Lovejoy's Narrows, to give a width of 170 feet and a depth of 18 feet at mean low water:

	Cubic yards.
Ledge formerly known as Dry Rock	3,626
Rock No. 4 (near ditto)	241
Half-Tide Rock Point	3,078
Spaulding's Island Point	1,063
Total	8,008

It is believed that the ledge can be removed for $12.50 per cubic yard, if the appropriations therefor be not extended over a long period. The estimated expense is thus made $100,100; this sum would be most economically expended in two years.

In addition to the above, there are numerous places between the south end of Swan Island and the dam at Augusta where small improvements are required, and for which no general plan or estimate can be submitted until the points have been carefully surveyed in detail.

Some deepening of the west channel is required nearly opposite the lower end of Swan Island.

In the east channel the first obstruction reached is locally known as Coxsackie Shoal. The river at this place is broad at high water, so that the current is too sluggish to cause a scour over the bar, defended at its head by a small ledge known as Beef Rock, which is only submerged at high water. This is perhaps the most extensive shoal in the main channel below Gardiner.

At the head of Swan Island is the Richmond Breakwater. It is a serious question among those interested in the river navigation and industries, and one which can only be answered by a survey and further observation, whether this breakwater by causing ice-jams in freshets is not injuring the channel it was intended to benefit, as well as causing loss in the ice crops above. The question is worthy of attention, though I am not at present able to give any definite information on the subject.

About half a mile above Swan Island opposite Lincoln ice-houses, there is said to be a rock in the channel on which several vessels have been injured; it has but 9 feet of water over it, though it is not shown upon the map obtained from the office of the Coast Survey.

A similar rock is in the channel about 3½ miles above Swan Island, opposite the middle one of Berry's ice-houses; this rock has but 5 feet of water over its top at low water.

Following up the channel we come to what is known as the Upper Sand Bar, where some dredging and probably a small jetty is required. In 1871 a channel 100 feet wide and 10 feet deep at mean low water was dredged through this bar, but this is entirely insufficient for the present necessities. A short distance above is Nehumkeg Rock in mid-channel, which was removed to 12⅔ feet at mean low water in 1871.

In very nearly mid-channel, 2¼ miles below the bridge at Gardiner, is a reef known as Green's Ledge, over which the chart shows a depth of but 4 feet.

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A short distance below the bridge at Gardiner the river is wide, and a spit known as Tarbox's Shoal requires some attention.

The draw of the bridge from Gardiner to Pittston is difficult and somewhat dangerous to pass, owing to the lack of suitable piers as guides to the current and guards for the passing vessel. I give this upon the statement of pilots and others without personal knowledge obtained from observation.

The bridge seems to have had an effect in forming a shoal in front of the wharves immediately above, and the shoal has extended downward until it has injured the channel through the draw; opposite the railroad wharf the shallow water causes great inconvenience and expense in getting vessels to and from the landing.

About 1½ miles above the Gardiner Bridge is Brown's Island, a small formation in mid-channel where the river is wide. In the eastern and principal channel is "Brown's Island Shoal."

From the last-named point to the bridge at Augusta, a distance of 5 miles, are Hinkley's, Shepard's Point, Hallowell, Britt's, and Gage's shoals, where, from 1867 to 1871, channels 100 feet wide and 6½ feet deep were cut by dredging.

On the 20th of February, 1870, the dam at Augusta was carried away, letting loose into the river below an immense accumulation of gravel, sand, and mill refuse. A portion of the refuse was subsequently removed from the channels which had been previously dredged, but the great mass remained in the river-bed and by degrees drifted into the channels and upon the shoals.

Most of the trouble now experienced above Gardiner is above the south end of Shepard's Point Shoal Cut, but to devise a complete plan for improvement soundings should be taken and platted on the maps covering the entire distance. A draught of 10 feet at high water is now the extreme amount which can be carried to Augusta, and even that depth is subject to great inconvenience and delay. The tidal range in this part of the river is about 5 feet.

The same freshet carried away the toll-bridge at Hallowell, leaving the piers in the river. The remains of the bridge piers are now submerged at high water and form a dangerous obstacle on which many vessels have been injured.

I am informed that a channel on the east shore at Augusta was greatly obstructed by débris, which was deposited in the water many years ago during the construction of the United States Arsenal, and that private enterprise has incurred considerable expense to remedy its worst features.

As before remarked, it is not now practicable to devise a definite project and estimate of cost of improvements which may be found necessary at these various places, but that the river is worthy of improvement by the General Government there is, in my opinion, no doubt.

The river forms one of the principal water communications from the sea-board to the interior of the State. Perhaps no other equal area in the country has so extensive a business in the cutting and shipment of ice; this is a grand annual crop, which practically costs nothing save labor to produce, so that the total receipts are a net benefit to the State, and it decreases the cost of this luxury in nearly every State on our Atlantic and Gulf coast.

Exports of granite and lumber figure to a considerable extent, as well as numerous other articles of smaller merchandise.

From Augusta alone there is shipped an annual average of 7,500,000 feet of lumber, requiring, with the present draught of water, fifty ves-

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sels to transport it. Freight on lumber is increased 45 cents per 1,000 feet, owing to the shoals at and above Gardiner; this is equivalent to a tax of $3,375 on this single interest in one town.

Large quantities of lumber from the valley of the Kennebec are carried by rail at greater expense than for water transportation to points further down the river in order that larger vessels and consequent cheaper freights may be obtained.

At Hallowell there are shipped by water from 10,000 to 15,000 tons of granite per year, on which the extra cost of freight due to shoals in less than 3 miles of the river below is given as 15 cents per ton.

From a member of the "Ice Exchange" I have obtained the storage capacity of ice-houses on the Kennebec River as closely approximating 1,200,000 tons. The amount of ice cut and shipped annually is, of course, less than the total capacity, and varies from year to year.

In the winter of 1885–'86 a large part of the best ice-fields were injured or ruined by freshets, so that nearly half the companies cut no ice at all, and others cut less than usual. The amount of ice cut and stored during the winter mentioned was 433,000 tons.

It is estimated that the average capacity of the vessels carrying ice will not exceed 700 tons, and upon this basis it would require over 600 vessels to carry the small crop harvested in this exceptional season.

The ice shipments above Gardiner, and probably granite also, would be largely increased were it possible to employ vessels having a greater draught of water. Articles of import are less numerous than those going out of the river; but they are sufficient to form in the aggregate an item of much importance. Over one hundred vessels per annum are required to bring to Augusta and Hallowell the coal alone which comes by water. There are also large receipts of lime, cement, bricks, etc. All of these freights are considerably increased in cost, owing to the obstructions and the smaller class of vessels which are necessarily employed. Freights on coal above Gardiner are increased 25 cents per ton by the obstructions above that place. The cities of Hallowell and Augusta thus pay annually $5,500 more for their coal than would otherwise be required.

Two regular lines of steamers ply upon the river as far as Augusta, one line running from Boston. The latter, however, is compelled to transfer its passengers and freights to a smaller steamer at Gardiner. With a good channel steamers would without doubt run direct from Augusta to Boston.

The Kennebec Steam-boat Line also has to make transfers at Gardiner to smaller craft when the stage of water is low.

I recommend that a survey be made of all the locations mentioned, in order that a complete project and estimate may be prepared.

A surveying party under charge of a competent assistant will cost $20 per day, and it is estimated that six weeks will be required to do the field work properly. Not less than one month's time of assistants will be required to plat the maps.

The following estimate for costs of survey, etc., is therefore submitted:

Expense of field work, 36 days, at $20	$720
Reducing maps and projects in office	200
Transportation of party, hire of boats, etc	80
Total	1,000

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

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SURVEY OF KENNEBEC RIVER, MAINE, AT BATH, AND FROM AUGUSTA TO LOWER END OF PERKIN'S ISLAND.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 9, 1888.

SIR: In accordance with instructions contained in Department letter of March 16, 1887, I have the honor to submit the following report of a survey of the Kennebec River, Maine, at Bath, and from Augusta to lower end of Perkin's Island.

In my preliminary report I explained that the island known and shown on the charts as Perkin's Island is below Bath, and that the island indicated for the termination of the survey contains the town of Perkin's, but is known as Swan Island. Swan Island is about 5 miles long, and the two channels by which it is inclosed are used for navigation, and both require improvement.

The entire length of the channel to be passed over by the survey was thus about 27 miles, besides what was required in the harbor of Bath.

The situation and character of a channel forming the approaches to an obstruction is often nearly as important an element as the obstruction itself in determining the location and extent of improvement which may be required.

The funds which could be allotted for this survey were insufficient to make it complete, with borings to ascertain the character of the bottom, and to cover the expense of making the maps.

I was therefore compelled to limit the work to a hydrographic survey of the river from Augusta to Gardiner and to such detached locations below as seemed to require improvement.

The survey was thus not only very much abridged, but even in that form every expedient was used to save expense. It has therefore been impossible to obtain all the information necessary to devise a project covering the complete and permanent improvement of the river.

The project for the improvement of the river navigation has been made as complete as possible with the information which could be thus obtained.

The field and office work have been under the immediate charge of Mr. F. S. Burrowes, assistant engineer, who, though only temporarily employed for the purpose, has pushed the work forward very rapidly and with a good judgment which is worthy of special commendation.

Mr. Burrowes's report is appended, to form part of my own, and thirteen tracings* from completed maps are forwarded in a separate package, to accompany my report.

The discussion of the commerce of the river was made so full in my preliminary report that no further statistics seem to be here required.

It is apparent, however, that as there are various shipping points for ice, lumber, stone, and merchandise, most of which is taken out in seagoing vessels, and at the same points receive return freights of coal, grain, provisions, articles of manufacture, etc., the number passing the channel at any one point diminishes as the river is ascended, and at the head of navigation only those vessels will appear which carry freights the entire distance.

It is therefore evident that the necessity for a deep channel which may be navigated at all stages of the tide diminishes towards the head of navigation; it is also true that vessels may arrive at and leave the upper terminus of navigation at high water, but to do this without delay en route points further down the river must be passed at low stages.

* Omitted.

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The requirements thus bear a relation to the volume of water in the river which passes a given point through the action of tides and tributaries, the channel becoming larger and deeper as the river is descended.

Augusta, the capital of the State, at the head of tide-water and of navigation, is a shipping point of considerable lumber and other merchandise, and a distributing point for coal and other articles brought in by sail vessels and regular steam-boat lines.

From Augusta to a point midway between Hallowell and Gardiner a depth of 8 feet at low water is all that can be maintained without incurring great expense.

The shoals are mainly of hard sand and gravel, with some bowlders, all of a kind not easily moved by the current. At the points where these shoals occur the river is too wide to obtain a good channel by the scouring action of the water, so that jetties to contract the width would be desirable; but it is believed that at present the additional expense would be disproportionate to the benefit, as the channels when dredged will be maintained without concentration of the current, at least for a long time.

It is therefore recommended that through Gage's Shoal and Britt's Shoal the channel be dredged, so as to give a depth of 8 feet at low water and a width of 100 feet. It would be well, also, to dredge the east channel at Augusta to a depth of 7 feet and a width of 50 feet.

Between Hallowell and Gardiner are four shoals. The channel through them should have a width as great as 125 feet. For the first two and upper part of the third a depth of 8 feet is all that can be readily obtained. For the lower part of the third shoal and for the fourth a depth of 10 feet is desirable, more especially for the reason that they reach points where heavy shipments of ice are made.

Immediately above the bridge at Gardiner is a small shoal which should be removed, and also a very small one, known as Steamboat Shoal, at a short distance below the bridge.

The amount of dredging required to complete the channel as indicated, from Gardiner to Augusta, is as follows:

SITU MEASUREMENT.

	Cubic yards.
Gage's Shoal	45,500
East Channel	5,500
Britt's Shoal	70,000
Hallowell and Shepard's Point shoals	41,000
Hinckley's Shoal	18,000
Brown's Island Shoal	33,000
Gardiner and Steamboat shoals	8,000
Total	221,000

One of the greatest difficulties to be experienced in this work is the dumping of the material in suitable places. The dumping must generally be near the shore, where the water is shallow and where the material will not be washed back into the channel, so that the distance of towing is often great and delay is caused by the necessity for waiting for high water. It is, therefore, not prudent to estimate the contract price of this work at less than 35 cents per cubic yard in situ.

At Hallowell the remains of the piers of a former bridge are still in the river, and two of them next the draw are not only inconvenient, but dangerous; both should be removed. For their removal the estimate is as follows, viz: 350 cubic yards of stone, etc., at $2.50 per yard, $875.

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The shoal below Nehumkeg Island, known as the "Upper Sand Bar," is situated in a wide part of the river, where an obstruction is naturally formed by the shifting sands.

The survey and the time for maturing plans of improvement have been so much restricted, that the plan of improvement which has been devised for this and perhaps for other places may be found to require some modification.

It seems probable that a properly located wing-dam and dike or training-wall will be sufficient to cause a scour which shall obtain and preserve a good channel through the shoal. It is possible that some dredging may be found necessary to assist the scour.

The wing-dam joining the dike with the shore must be very strong to resist the force of ice, and its top should be a little higher than the top of the dike. A footing of brush should be provided, to prevent undermining by scour, and most of the work should be of heavy stone.

The estimate is for a wing-dam 20 feet wide on top and 5 feet high, and for a dike 10 feet wide on top and 4 feet high, both having slopes of 45 degrees.

A dredged channel is represented upon the map, but I feel so confident that the dike and wing-dam will accomplish all that is required, that no estimate for dredging is considered necessary.

The obstruction made by Berry's Rock will probably require attention at some future time, but in view of the fact that numerous other points exist where the channel demands immediate attention, this place may very properly be passed over without an estimate for improvement at present.

Some years ago a jetty of stone was constructed at the head of Swan Island for the purpose of diverting the current and causing a scour in the west or Richmond Channel. It is quite apparent that the jetty has not accomplished all that was expected or hoped; but, on the other hand, it is very urgently claimed that it has been a means of injury to the ice crop by causing a jam in time of winter freshets.

Be this as it may, my judgment is that the channel would be improved by removing the outer end of the jetty for at least a third of its length, and to place the stone on a line from the end of the jetty thus shortened toward the point of rocks a short distance below, on the Swan Island side of the Richmond Channel. To do this will require the shifting of 6,000 tons of stone, at an estimated cost of 50 cents per ton.

At Swan Island the eastern channel is by far the more important, as it is the main thoroughfare for most of the heavy shipping.

The steamers and some other vessels, however, use the west channel, owing to the necessity for touching at Richmond, which is a thriving town.

In my preliminary report I referred to the obstruction by ledges of rock at Lovejoy's Narrows, in the east channel of Swan Island.

As a survey of this work had been made some years ago, I forwarded in the same report a map of the narrows, and an estimate of the cost of its improvement by removing the ledge to a depth of 18 feet and a width of 175 feet.

This is probably the most important improvement upon the river, with the possible exception of Beef Rock Shoal, which is further downstream in the same channel.

The estimate for removal of this ledge was made $100,100.

Toward the south end of Swan Island the east channel becomes very wide, and has a sandy bottom; a long bar is thus formed, with its upper end protected by a ledge known as Beef Rock.

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No channel that can be made through this shoal will have any degree of permanence until the current of the river has been concentrated within similar bounds to those which maintain a sufficient depth at other places.

The removal of the ledge at Reef Rock would be expensive, and as a good channel on either hand may be maintained by a dike or long wing-dam from the east shore shortly above Beef Rock, and extending down-stream parallel to a line joining the projecting points of the island, it is considered best not to remove the rock, but to mark its location by a beacon.

At present the tow-boat company maintains three small lights along the banks near this shoal; and a single light upon this beacon would furnish a sufficient mark, and one which could be seen more than a mile and a half above and nearly twice that distance below.

The tracing sufficiently indicates the plan of improvement at this place. It is probable that no dredging will be required.

The design for a dike places its top 4 feet above mean low water and gives it slopes of 45 degrees on each side. The top has a width of 15 feet where the old channel is crossed, and a width of 10 feet the remaining distance.

It may be also found necessary to construct a wing-dam across the small bay on the island nearly opposite the middle of the dike, and a second wing-dam opposite the lower end of the dike to direct the current into the deep water below, so that the deep channel may be uninterrupted.

To build the dike and wing-dams will require 80,000 tons of stone, at an estimated contract price of $1 per ton in place.

To protect the foundation in places where it is likely to be undermined by scouring, will require 8,000 cords of brush, at an estimated cost of $3 per cord in place.

The beacon upon Beef Rock must be strongly built to resist the pressure of ice which will come upon it.

It will require 152 cubic yards of good masonry, at estimated cost of $10 per yard by contract.

As before explained, it is not probable that any dredging will be required, and although a cut is indicated upon the map there is scarcely a doubt that all needed depth will be obtained by the scour of the current, so that no estimate for dredging is considered necessary.

The west channel at Swan Island has but one obstruction which is considered worthy of notice at present; this is known as Hatch's Rock Shoal. The stream at this place is so wide that no channel of good depth can be maintained without wing-dams and training-walls to reduce the width and secure a scouring effect by the current.

The channel dredged some years ago was filled again in a short time, and a repetition of the experiment is not advisable.

Three wing-dams of stone and brush are recommended essentially as indicated on the map. (Sheet No. 11.)

These works will require 15,000 tons of stone and 1,200 cords of brush.

I believe that the wing-dams will accomplish all that is necessary, without any resort to dredging, but in any event the contraction works are indispensable to maintain a channel.

While there are other points between Augusta and the foot of Swan (Perkin's) Island, which might be improved, those here discussed include all that seem to demand any immediate attention.

In the river at Bath are several ledges which are annoying, but with one exception they do not seem to be in the way of general navigation

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of the river, and I do not even regard this one as of vital importance. The ledge is locally known as Houghton's Rock. If removed at all, the depth should be made at least 20 feet; otherwise it would be as likely to do damage as it is at present.

The shoal, above 20 feet depth, contains 343 cubic yards, about three-fourths of which is ledge. It is estimated that its removal will cost $20 per cubic yard for the entire amount.

The following is a condensed estimate of the improvements here proposed, and the various places are arranged, with the exception of Bath, in the order of their distance above the foot of Swan Island, and this indicates in a general way the order in which I consider it advisable to carry on the work:

Beef Rock Shoal: Stone and brush dike and wing-dams	$104,000
Beef Rock Beacon	1,520
Hatch's Rock Shoal: Three wing-dams	18,600
Lovejoy's Narrows: Removing 8,008 cubic yards ledge, at $12.50	100,100
Modification of jetty at head of Swan Island	3,000
Upper sand-bar, wing-dam, and dike:	
51,000 tons of stone, at $1	51,000
3,350 cords of brush, at $3	10,050
Removing bridge-piers at Hallowell	875
Removing shoals from Gardiner to Augusta	77,350
For superintendence, surveys, and engineering, contingencies, add about 10 per cent	36,505
Total	403,000

Houghton's Rock being at Bath and separated from the other improvements, its removal is estimated separately, viz:

343 cubic yards, at $20	$6,860
Engineering contingencies	640
Total	7,500

For a more detailed description of the survey and discussion of the subject, I invite attention to the report of Mr. F. S. Burrowes.

In closing this report it seems proper to ask attention to the fact that the amount of navigation on the river is very large, and the commerce is of a kind which makes the rate of freights a matter of interest to a large section of country, especially along our Atlantic coast.

Upon many other rivers in the country the importance of small and inexpensive lights to mark bends or crossings in the channel has been fully recognized, and the want has been supplied.

A few such lights judiciously located upon the Kennebec River would be of great advantage, and I recommend that the subject of such lights be considered as an important factor in improving the navigation.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. F. S. BURROWES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 20, 1887.

MAJOR: I have the honor to submit the following report upon a survey of the Kennebec River, Maine, at Bath and from Augusta to the lower end of Perkin's (Swan) Island, made under your direction in accordance with river and harbor act of August 5, 1886. As shown in your preliminary report, the Perkin's Island of the act is the one locally known as Swan Island, and will be referred to by that name throughout this report.

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The survey was commenced at Augusta, July 5, 1887, the party consisting of one assistant engineer, one instrument-man, two recorders, one rodman, one leadsman, two boatmen, and a cook. In order to expedite the work two small flat-boats with rough cabins on them were hired, in which the party lived and which were dropped down the river as the work progressed. The field work was completed at Bath, August 13, and the party disbanded.

As with the funds available it was not possible to make a continuous detailed survey of the river between the points named (a channel length of 27 miles), it was determined to make close examinations at those points only where navigation was known to be obstructed, and to entirely omit the parts in good navigable condition as shown by the charts of previous surveys as well as by the testimony of those constantly using the river. In accordance with this decision, the following general plan was pursued:

Between Augusta and Gardiner, a distance of 6¾ miles, there are six shoals, locally known—beginning at Augusta—as Gage's, Britt's, Hallowell, Shepard's Point, Hinkley's, and Brown's Island shoals, the latter 1½ miles above the bridge at Gardiner. A continuous survey was made of the portion of the river including these shoals, as the pools between them are short and as a definite knowledge of their depth would be necessary in determining the depths to be made through the shoals. Four charts made to a scale of 1 : 2000 show this portion of the river, and a fifth to the same scale shows the channel in the vicinity of the bridge at Gardiner.

Between Gardiner and the foot of Swan Island in the main (that is eastern) channel the localities surveyed and mapped are as follows: Green's Ledge, Chart No. 6, scale 1 : 1000; Upper Sand Bar at South Gardiner, Chart No. 7. scale 1 : 2000; rock at Berry's ice-houses, Chart No. 8, scale 1 : 1000; and Beef Rock Shoal, in eastern channel of Swan Island, Chart No. 9, scale 1 : 2000. These are the only points in this portion of the main channel at which improvements could be made with signal benefit to navigation, except Lovejoy's Narrows, also in eastern channel at Swan Island, where some work has already been done, and of which sufficiently detailed surveys have been made on which to base estimates for further improvement.

In the western channel at Swan Island surveys were made of breakwater and shoal at head of Swan Island. Chart No. 10, scale 1 : 2000 of Hatch's Rock Shoal; Chart No. 11, scale 1 : 3000, and of shoal at foot of Swan Island, Chart No. 12, scale 1 : 2000.

At Bath surveys were made of three ledges near the wharves and mapped on one chart, No. 13, scale 1 : 1000.

MANNER OF MAKING SURVEY.

The same question of economy influenced largely the methods of making the survey adopted, so that as much time as possible could be given to the location and determination of the soundings.

On the continuous portions of the survey a measured azimuth line was run down the river and points on opposite shore located by triangulation, buildings, wharves, points on high-water line, and other topographical features being located by stadia measurement.

On the shorter shoals a system of triangles was used, the topography being filled in with the stadia. Wherever practicable the stations were marked by drill-holes in the ledge, or established with reference to prominent landmarks, such as corners of wharves, buildings, etc. No attempt was made to make a close topographical survey of the banks above high-water line.

SOUNDINGS.

All soundings were located by intersection, either with two instruments, or on one instrument and an established range. The depths were measured either with a sounding lead and graduated brass chain or with a graduated rod, the latter being used for depths less than 20 feet.

TIDES.

As it was not feasible during the survey to make a continuous series of observations at one point for the determination of the rise and fall of tides, the planes of reference of mean high water, mean low water, and lowest water were taken from charts and bench-marks of previous surveys. The mean oscillation of tides from these data is about 5 feet throughout the whole length of the river from Augusta to foot of Swan Island. The tide-gauges on which observations were made for reduction of soundings were connected with each other by simultaneous observations at slack-water. A bench-mark was established for each gauge, the locations and elevations being indicated on the charts, and, wherever possible, were connected with bench-marks of previous surveys.

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AUGUSTA TO GARDINER.

All the shoals in this reach of river, that is Gage's, Britt's, Hallowell, Shepard's Point, Hinkley's, and Brown's Island, with the exception of the last named, have been improved by the General Government, the improvements consisting in dredged channels 100 feet in width and 6½ feet in depth on the first two, and 7 feet in depth on the last three shoals. The plane of reference used was the lowest water observed in the summer of 1867. For convenience of comparison the same plane of reference for soundings was adopted in this portion of the present survey, connection being made by means of the bench-mark at the lower tide-gauge at Hallowell, as it was the only one which remained undisturbed or could be definitely located. This plane, being that of an exceedingly low run of summer tides, is at least 2 feet below usual low tides, so that any improvement made with it as a datum would ordinarily yield 2 feet more depth than that indicated.

Gage's Shoal begins 1,200 feet below the bridge at Augusta, is 2,800 feet long between the 8-foot curves, and has a least depth of 5½ feet. Through a large part of the dredged channel, however, the depth of 6½ feet has remained and the partial shoaling may have been caused by the freshet, which carried away the dam at Augusta, bringing with it much silt and heavy débris, which it was unable to carry far. The material of which it is composed is coarse gravel and large bowlders.

Britt's Shoal ends a short distance above the old bridge site at Hallowell; it is 3,700 feet in length between 8-foot curves, and has a least available depth of 4.7 feet. Throughout most of its length, however, the dredged channel has maintained its depth of 6½ feet. The material of which it is composed is coarse gravel and sand. At both Gage's and Britt's shoals several large bowlders close to the edge of the channel add hazard to navigation. The depth to be obtained by improvement should be the same for both shoals, as they are close together and there is no shipping point between them.

At Hallowell the piers of the bridge carried away by a freshet remain standing and obstruct navigation to some extent; the piers which caught the ends of the draw being especially hazardous, as their tops are nearly in the plane of low water.

Hallowell and Shepard's Point shoals are practically continuous, and beginning just below the wharves at Hallowell have a combined length of 4,700 feet between 10 feet curves. The dredged channels have maintained their depths of 7 feet, but have been somewhat narrowed.

Both of these shoals are in excessively wide portions of the river. The cuts were made in nearly straight lines through the flats, the crooked natural channels which followed the shores being abandoned. The material appears to be mostly sand, with some gravel.

Hinkley's Shoal, 2½ miles above Gardiner, is also in a wide part of the river. Its length, between 10-foot curves, is 2,200 feet, and least depth 6.5 feet. The material of which it is composed is sand, coarse gravel, and possibly some ledge.

Brown's Island Shoal is at the head of and opposite Brown's Island, which here divides a very wide part of the river, the western part being shallow and the eastern and navigable channel being narrow and crooked, with a least depth of 6.5 feet. The material of which this shoal is composed is apparently sand and loose gravel.

About midway between Brown's Island and Hinkley's shoals the channel, although maintaining a depth of 10 feet, becomes very narrow, and should be widened in order to make this depth available for navigation.

Between Brown's Island and Gardiner there is a least depth of 10 feet, and this appears to be the limit which could be obtained above that point without excessive cost. This depth could be made through Brown's Island and Hinkley's shoals, and perhaps through Shepard's Point and Hallowell shoals. Above Hallowell a depth of 8 feet would be sufficient for present navigation, and is perhaps all that could be obtained without outlay disproportionate to the benefits derived therefrom.

Immediately above the bridge at Gardiner the water has shoaled in front of the wharves, the cause being presumably the checking and deflection of the current by the piers of the bridge. Below the bridge, and just off the lower end of the Boston steamer wharf, is a shoal composed of logs and sawdust, with bowlders on top, which are only 6½ feet below low water. It is known as the Steam-boat Shoal, and is in such a position as to be a source of danger to boats loading at the wharf. One-half mile below the bridge at Gardiner the river widens and the channel becomes shoal and crooked. It maintains, however, a least depth of 11½ feet at lowest water.

GARDINER TO SWAN ISLAND.

The portion of the river from Gardiner to the head of Swan, a distance of 10 miles, is remarkably free from serious obstructions and has throughout almost its entire length an available channel depth of 13 or 14 feet at mean low water. Along this

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part of the river are most of the large ice-houses, the shipments from which constitute the great bulk of the commerce of the river. The obstructions, of which surveys were made, are Green's Ledge, Upper Sand-bar, and rock at Berry's Ice-house.

Green's Ledge, 2¼ miles below Gardiner, is a ledge of rock nearly in mid-river It is about 150 feet long and 50 feet wide, and has a least depth on it at mean low water of 3 feet. To the west of it there is a channel 175 feet wide and 14 feet deep. As the river here is nearly straight, the ledge, if well buoyed, would not greatly interfere with navigation. Its removal so as to widen the channel would, however, be a benefit.

The Upper Sand-bar is opposite the lower end of South Gardiner, and just below Nehumkeg Island. It is a sand-shoal, which reaches entirely across an excessively wide section of the river. A channel 100 feet wide and 10 feet deep at low water was dredged through the bar in 1871. This channel has been partly filled in by the shifting sand, and it would seem that in order to maintain a channel some auxiliary works would have to be constructed to reduce the width of the cross-section. The present length of the shoal, between 14-foot curves, is 2,500 feet, and there is a least available depth through the old cut of 9½ feet at mean low water.

Berry's Rock is a ledge in front of Berry's Ice-houses and about 1½ miles above Iceboro. It is about 90 feet long and 60 feet wide, and has a least depth on it of 5 feet at mean low water. It is nearly in mid-river, but there is a clear channel to the eastward of it 200 feet wide and 16 feet deep at mean low water. If well buoyed it is not a serious obstacle to navigation, but, as in the case of Green's Ledge, its removal would allow of the handling of large tows with greater safety.

SWAN ISLAND CHANNELS.

Swan Island divides the river into two channels for a distance of 5 miles, beginning about a mile above the landing at Richmond. The easterly channel has the greater depth of water through it, and is consequently always used by the deep-draught vessels. It is obstructed at only two points, Lovejoy's Narrows and Beef Rock Shoal. The former, as previously stated, has been improved by the removal of rocks from the channel, and an estimate submitted for its further improvement The plane of reference for the soundings used in present surveys of the Swan Island channels is mean low water, as established by the United States Coast and Geodetic Survey, and is same as the one used for the various improvements made in the vicinity.

At Beef Rock Shoal the river is very wide, and is divided at low water by a middle bar into two channels, in each of which there are shoals having a depth of only 10 feet at mean low water. The formation of this bar is caused by the ledge at its head known as Beef Rock, and which projects 4.5 feet above mean low water. The concentration of the water in one channel would doubtless cause scouring action sufficient to yield a good navigable depth through the shoal; it would at least be a necessary part of a plan to maintain a channel however obtained. The easterly channel is the one at present most used, the shoal being shorter, and it would seem to be the most available for improvement, as the material of which it is composed appears to be all sand, and there would be less likelihood of encountering ledge than in the westerly channel, which follows close along the rocky shore of Swan Island. The depth to be obtained at this shoal should be at least as great as the draught of the largest vessels navigating the river, as tows start from points above at high tide, and reaching this point at or near low water are often delayed until the next high water. The draught of vessels at present using the river seldom exceeds 15 feet.

Swan Island, western channel.—The western channel is used almost exclusively by the steamers plying between points up the river and Boston, Portland, and the mouth of the river, being compelled to take this route in order to land at the town of Richmond, about a mile below the head of the island. The greatest draught of any of these boats is 9½ feet, and as for a distance of 2¼ miles the available depth of the channel is barely 10 feet, it would be useless to attempt to obtain a greater depth than that through the shoals.

At *Head of Swan Island* a breakwater has been constructed, extending from the head of the island 550 feet up-stream, with the evident intention of diverting a greater proportion of the water down the west channel. At the same time a channel was dredged through the shoal opposite the breakwater to a depth of 10 feet at mean low water. This channel has shoaled somewhat, but there remains now an available depth of 9½ feet over the shoal. It is doubtful if the breakwater has been efficacious either in scouring or maintaining the channel. It is claimed by some of the parties engaged in the ice traffic that it causes the ice to break up and jam, and prevents the formation of smooth ice-fields suitable for cutting in its vicinity.

Hatch's Rock Shoal, 1 mile below Richmond, is a sand-bar in a wide part of the river, through which a channel was at one time dredged to a depth of 10 feet at mean low water. There is a barely perceptible trace of this channel now to be found, the depths through it varying from 7.5 to 8 feet.

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In order to maintain a channel here it would seem to be necessary to reduce the river to a width normal for the depth required. The present length of the shoal between 10-feet curves is 2,000 feet.

At *shoal at foot of Swan Island* a channel was also dredged to a depth of 11 feet at mean low water, and has shoaled but slightly since.

Bath.—At Bath three rocks lying close to the wharves were sounded. The lower one is 50 feet off the Steam Mill Wharf, and is about in the middle of the small channel between this wharf and the large ledge known as Steam Mill Rock. Its top is only 2.5 feet below mean low water and is in the way of vessels being dropped against this wharf.

The second rock is 185 feet off Haughton's Wharf, its top being 13 feet below mean low water and 7 or 8 feet above the general level of the surrounding bottom. One or two heavily laden vessels have been known to hang on the rock for a short time at low tide. It is the only one of the three rocks surveyed which could be regarded as at all interfering with the free navigation of the river.

The third is close into the railroad wharf, its top being 12.5 feet below mean low water. It is small and unimportant, and entirely out of the way of navigation.

RESUMÉ.

The foregoing detailed descriptions are held to include all the points at which improvements could be made with reasonable economy and without altering the regimen of the river.

First in order of importance to the principal commerce of the river, that is, the deep-draught vessels carrying ice, is the improvement of the Beef Rock Shoal, which would prevent the delay of twelve hours to the large tows. The upper sand-bar is also a fruitful source of annoyance and delay, as the channel being narrow as well as shoal large tows can not be taken through it unbroken.

The improvement of Brown's Island and Hinckley's Shoals would carry the channel to the present head of the heaviest ice traffic. Further up lighter vessels are, of necessity, used for bringing ice, stone, and lumber from points above.

The principal immediate advantage of the improvement of this upper portion of the river would be the prevention of vexations and costly delays to the steam-boats, and as they are also compelled to navigate the western channel at Swan Island the improvement of Hatche's Rock Shoal is of vital importance to them.

The removal of Green's Ledge and Berry's Rock would be a benefit to navigation, but is of less importance than the improvements at the other points named.

I was unable to obtain any statistics of importance touching the commerce of the river other than those given in your preliminary report, which, however, show conclusively the importance of the river as an artery of trade and the necessity for its improvement.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Maj. JARED A. SMITH,
Corps of Engineers, U. S. A.

A 20.

PRELIMINARY EXAMINATION OF PENOBSCOT RIVER, MAINE, FROM BANGOR TO BUCKSPORT NARROWS.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 11, 1887.

GENERAL: I have the honor to submit the following report of a preliminary examination of the Penobscot River, Maine, from Bangor to Bucksport Narrows, in accordance with instructions from the Chief of Engineers dated September 27, and October 28, 1886.

On the 14th and 15th of December, 1886, I visited Bangor and Bucksport, and also went in a tug over the portion of the river where improvements seem to be required.

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From the facts gathered by observation and inquiry, it is my opinion that the portion of the river indicated is well worthy of improvement by the General Government.

This opinion is based upon the following points:

The head of navigation of the river at Bangor is, by the channel, 19½ miles above the "Narrows" at Bucksport, 27 miles above the mouth of the river at Fort Point Ledge, on Penobscot Bay, and 62 miles above the headlands of the coast.

Navigation at Bangor includes regular lines of steamers and many sailing vessels, affording communication with the interior of the State, and intersecting the lines of railroads which reach across the State into the provinces of New Brunswick and Nova Scotia.

During about three months in the winter at Bangor, and over a distance of several miles below, the river is closed by ice, so that the steamers and sail vessels make their landings at Winterport, about 14 miles below Bangor.

From April to December, 1886, inclusive, 1,798 sailing vessels were taken up the river to the wharves at Bangor and returned; the average tonnage of these vessels is estimated as not less than 300 tons each. Most of them carry freights in both directions, though the outward freights are much the larger. In addition to the above there are about 300 vessels of less than 50 tons each, of which no regular reports are made by the harbor-master.

During the year, and especially from December to March, inclusive, a large number of vessels receive and discharge cargoes at Winterport; the number of these amount to several hundred in all, but I have not been able to obtain the exact figures.

At Bucksport, above the "Narrows," there were 150 arrivals and 137 departures during the year 1886.

Sixty-three vessels are owned in Bucksport alone.

The Boston and Bangor Steamship Company ran a steamer six times per week during the summer season, and four times per week during the remainder of the year.

The Bangor and Bar Harbor Steam-boat Company run a steamer twice weekly during the summer and early autumn months.

The regular steamers, added to the tugs employed upon the river, make a large total for the amount of navigation and the value of interests involved.

The obstructions to navigation are all included between Bangor and Bucksport Narrows. They are not numerous nor of a character difficult to remedy; they consist almost entirely of bars in the wide part of the river between Bucksport and Winterport, though it is probable that some minor points above may require attention.

A project for improvement of the river from Bangor to Crosby's Narrows is still incomplete. Surveys above that point have been already made.

Many of the vessels plying on the river to Bangor draw from 15 to 18 feet of water, and in one instance a vessel drawing 22 feet and 7 inches was towed down the river at high water. The greatest depth over the bar below Winterport is not more than 11 feet at mean low water. This causes great detention and some danger to vessels in tow of a tug.

As the Coast Survey charts are not in sufficient detail for the purpose required, I recommend that a survey of the river be made from Crosby's Narrows to the narrows at Bucksport, a distance of 16 miles. For the part above Winterport soundings may be made at wide intervals; be-

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low that place, a distance of 5½ miles, the survey should be made carefully in detail. The expense of such a survey is estimated as follows:

Field work of surveying party in charge or assistant engineer, fifty days, at $20	$1,000
Incidental expenses of transportation, hire of boats, purchase of lumber, nails, etc	200
Salary of assistant engineer and for office expenses, platting maps, and completing a project for necessary improvements	300
Total	1,500

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF PENOBSCOT RIVER, MAINE, FROM BANGOR TO BUCKSPORT NARROWS.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 11, 1888.

SIR: In compliance with instructions from the Chief of Engineers, dated March 16, 1887, I have the honor to submit the following report of a survey upon the Penobscot River, Maine, between Bangor and Bucksport Narrows, and to include in the report an estimate of the cost of works of improvement.

The amount of funds allotted for this survey was very small, so that it was impracticable to make a general survey between the limits indicated, and I was compelled to limit the work to the portion included between Winterport and Bucksport.

The surveys, projects, and estimates hitherto made and laid before Congress cover the part from Bangor to Crosby's Narrows, and below the latter point there is no obstruction worthy of present consideration save in the portion which has been included in this survey.

Below Winterport the river makes a bend, so that the direction of the current is changed to about a right angle from its former course.

At this place the river becomes nearly three times as wide as it will average at points above, and it is fully twice as wide as at any place in the river where a good channel is maintained by natural conditions.

The place is known as Frankfort Flats. Being in a bend, the great width is less prejudicial than it would be in a straight reach, because the strongest current follows the outer part of the bend, and is thus more rapid than if it were uniformly diffused.

Opposite the middle of the flats is a tidal arm and tributary of the Penobscot known as Marsh River. The ebb tide from this river sets out very strongly, and assists in producing effects in the current below its mouth, which cause great irregularity in the channel.

These irregularities are continued some distance below the flats to a point known as High Head.

Owing to the limitations in the survey I found it impracticable to obtain a competent and reliable man to do the work, and was, therefore, under the necessity of assigning it to Mr. A. C. Both, assistant engineer, whose duties upon other works of importance made it impossible to give his time until nearly the 1st of October.

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I was compelled to close the field work on the 1st of November from lack of funds, though the current observations were incomplete and no borings had been made.

The map has been made in the office by Mr. Both, and the studies for the improvement have been made by him and myself in mutual discussion and consultation. The resulting plans and estimates of cost are discussed in Mr. Both's report, which I inclose as part of my own, and to which I invite attention.

A tracing of the map covering the survey and plan of improvement is forwarded in a separate package.

It is very apparent to me that a good channel can not be made permanent at this place without constructing works to concentrate the flow of water within bounds similar in extent to those where a good channel is found in other places.

Having constructed the jetties which are indicated, with any changes or modifications which may be found advisable, it is probable that the amount of dredging for which an estimate is submitted will be greatly reduced, if not eliminated entirely, by the increased scour of the river.

This effect depends upon the character of the bottom, which I have not been able to examine with sufficient care to predict the effect of increased current velocity with any certainty. Should it accomplish what is hoped and what seems probable, the total estimate of $365,000 will be decreased by more than $100,000.

For a further discussion of the subject, I refer to my preliminary report and to the very complete report of Mr. Both.

Very respectfully, your obedient servant,

JARED A. SMITH,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. A. C. BOTH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., January 3, 1888.

MAJOR: I have the honor to submit the following report upon a survey of the Penobscot River, Maine, between Bangor and Bucksport, required by river and harbor act of August 5, 1886.

In compliance with your orders I proceeded to Winterport, Me., on September 27, 1887, and commenced the survey the following day.

The depth now available in this part of the river for safe navigation is about 16 feet at mean low water. By using great care single vessels drawing 18 feet may be taken through this channel. Nearly all the vessels bound for or sailing from Bangor avail themselves of the fine tow-boat service maintained between Bangor and the mouth of the river (Fort Point), 25 miles below, and as most of the tows consist of from six to twelve and more vessels, the tortuous courses which are necessary to be followed by deep-laden vessels can not be made with that accuracy required for their safe passage over the existing bars. All the tows bound up-river start at its mouth (Fort Point) at or before low water, passing through the channels between Bucksport and Winterport at the low stages of the tide, in order to arrive at Bangor at time of high water. On the other hand, all tows leaving Bangor start at high water, and pass the channel between Winterport and Bucksport at time of low water. The improvements made and contemplated in Bangor Harbor provide for a depth of about 14 feet at average low-water stage of the river (or 11 feet at extreme low water).

The mean rise and fall of the tide here being 13½ feet (from United States Coast Survey records), the high-water depth would be about 27 feet. The draught of the largest class of vessels loading at Bangor for foreign ports is from 20 to 22 feet, and it is, therefore, desired to obtain a low-water depth for the channel between Winterport and Bucksport, of not less than 22 feet, or, if possible, 24 feet, so that these vessels arriving here at time of low water may be able to pass with safety and without delay.

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TRIANGULATION AND TOPOGRAPHY.

The straight and level stretch of the east shore of the river, about a mile below the steam-boat wharf at Winterport, was selected for measuring a "base-line." The distance between the north and south base, carefully measured with a steel tape, is 3,727.05 feet. The northerly end of this line is marked by a hole, five-eighths inch in diameter, drilled into an embedded granite bowlder located at the high-water mark. The southerly end is marked by a similar hole drilled into the flat top of a solid ledge. The direction of this line is about 29° 30′ west of the magnetic meridian.

All the triangulation stations are marked by holes drilled into either large bowlders, not likely to be disturbed by ice or freshets, or into solid ledge, and in such places where neither a bowlder nor ledge was available, suitable rocks were selected and set into the ground level with its surface.

For signals over these numerous stations new broom-handles were used with good advantage; they are quickly fitted and driven into these holes, easily removed and replaced before and after occupation of stations by the instrument, are always available for observation, and will stand plumb in any weather or wind without bracing, and thus save a great deal of valuable time. Small red and white cotton flags, 10 inches square, single and in pairs, are nailed to these sticks for ready identification.

The prominent features of the shore-lines between the triangulation stations were determined by telemetric measurements. The triangulation stations on the west side of the river are marked I, II, III, to XXII, and those on the east shore A, B, C, to W. The survey of Bucksport Harbor, made by me in May, 1875, was connected trigonometrically with this survey, and has been reduced and copied on the accompanying plan.

SOUNDINGS.

All the soundings shown on this plan were taken on ranges established for that purpose, and were located by intersection angles taken with transit instrument from suitable stations on shore. For each sounding the boat from which they were made was brought to a stand-still to insure plumb soundings. At times when the tidal currents were too strong to obtain plumb soundings in this way, the boat was pulled above the ranges and then dropped down, the leadsman being in readiness to catch a plumb reading on crossing the range. A brass chain and 10-pound lead were used for taking soundings.

TIDE AND BENCH-MARKS.

Tide-gauges were established at Colby's Wharf in Bucksport, and at Boston and Bangor Steamer's Wharf in Winterport. The gauge at Bucksport was nailed to the outer face of Colby's Wharf and referred to a bench-mark at Fort Knox Wharf, established by me while making a survey of Bucksport Harbor in 1875. The reference of this bench-mark is 13.3 feet above mean low water. It was obtained from a tide-gauge which I found at Colby's Wharf, and which had been used the year previous (1874) by the United States Coast Survey. The record of that office gives the following data:

	Feet.
Mean rise and fall of tides	10.3
Highest observed high water above plane of mean low water	12.1
Lowest observed low water below plane of mean low water	2.7

The reference for the gauge at the Boston and Bangor Steamer Wharf in Winterport was obtained by a careful transfer of the reading at the Bucksport gauge at high-water slack, which occurs very nearly at the same time at both places. The reference of the Winterport gauge was transferred by level to a large, partly embedded granite bowlder, the highest point of which is 15.75 feet above the zero of that gauge. The location of this bowlder is given on the map.

CURRENT OBSERVATIONS.

A few observations only could be made to determine the directions and velocities of the ebb currents. One set was made October 31 in the wide portion of river below Winterport and one set on November 1 above High Head. The result of these observations are shown on the map and give the exact course taken by the float, and the velocities in statute miles per hour. The float used was made of dry pine, 4 inches diameter and 12 feet long, weighted at one end with iron, so that the other end would protrude a few inches only above the surface of the water. This end carried a small flag on a wire rod. At intervals of one minute angles were taken simultaneously by two observers on shore to a signal held vertically above the float by one of the men following the float in a boat. The locations of the float and the velocities of the current

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(between these locations), however, are given on the map for intervals of five minutes. The rise of the tide on October 31 was 11.2 feet, and on November 1 it was 11.3 feet, occurring at 9h. 55m. and 10h. 35m. a. m., respectively, and may be considered average high waters. I would here state, however, that the currents at the high runs of the tides have considerable higher velocities, and that during the time of the yearly spring freshets the velocities are certainly twice as high as those shown on the map.

As far as is known extensive changes of the river bottom take place mostly during freshets. Should it be decided to improve the channel in these parts of the river by contraction works, which seems to be the only sure method to procure permanency to any contemplated improvement, the currents of these freshets will aid materially in removing, by scour, the shoals now obstructing navigation, while the velocities of the current at other times will be ample to prevent the lodgment of any sediment, especially the sawdust which the waters of this river carry.

BORINGS.

In order to investigate the nature of the shoals at the different places, it was the intention to make careful borings. The apparatus being in readiness for commencing these borings on November 2, on the evening of November 1 I received from you a telegram ordering me to suspend all operations for want of necessary funds.

I therefore at once discharged the party, and returned to this office the following day.

From observations made during the survey I feel inclined to believe that these shoals consist mostly of slabs, edgings, and sawdust deposited here by favorable eddies and accumulated during many years.

I would recommend, however, that before actual work is commenced a thorough examination of these shoals be made to determine without doubt if a continuous channel of 22 or 24 feet depth can be obtained by the scouring action produced by contraction works alone, or if it will be found necessary to dredge a certain portion of the proposed channels and thereby hasten the availability of these channels for navigation.

Since returning to the office the survey has been plotted to a scale of 1 : 5000, and a copy of same is herewith submitted. The frequent interruptions caused by other duties which I had to attend to have delayed an earlier completion of the map and report.

PROJECTED IMPROVEMENTS AND ESTIMATED COST.

Since completing the map, works for improving the channel have been projected in frequent consultation with yourself. They consist mainly of a system of jetties and some dredging, should it be found necessary. The work which the jetties are intended to perform is twofold and closely dependent upon each other.

First. A contraction of the cross-section of the river at the different places to such an extent that the currents resulting therefrom shall tend to scour the material and carry the same to deep water to procure a continuous channel of at least 800 feet width and 22 feet depth through these shoals.

Second. To direct the currents in such a manner that the resulting channel shall present easy curves; whether obtained by scouring or dredging, or both combined, the channels once obtained will be permanently preserved by the current as then directed.

Should future examination of the shoals reveal the fact that dredging has to be resorted to in order to assist the scouring action it is proposed to cut a width of 400 feet and a depth of 22 feet at mean low water and to leave the remaining shoal ground to be scoured by the currents.

In view of the scarcity of brush in the vicinity of the work, and the very close proximity of granite quarries, it is proposed to build the jetties of granite grout, which can be had in large quantities and at reasonable cost.

The design of the jetties gives the tops an elevation of 6 feet above mean low water, so as not to obstruct the river too much at times of heavy freshets and ice, which would endanger the stability of these jetties, unless built very massive.

In view of the fact also that the strongest currents of the ebb tide fall between the time of half-tide and low water, the height of jetties is believed to be ample.

The jetties are proposed to be 10 feet wide on top, with slopes of 1 on 1, constructed by systematically dumping the stone in place and above the level of low water, laying it carefully, the top to be finished with heavy split stone of about 2 feet rise and 10 feet length.

The ends of the jetties should be protected by strong headings to resist the currents and ice and to form the base for beacons to indicate the channel. These headings or piers are planned as frustrums of pyramids, the tops at high-water level and the slopes being 1 on 1½.

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Surmounting these are stone beacons 12½ feet high. They are proposed to be built of split dimension stone, set in cement mortar, in five courses of 2½ feet rise each, lower course 12 feet square and upper course (top 22½ feet above mean low water) 8 feet square.

Estimated cost.

Jetties located at—	Length in feet.	Quantity of stone in jetty, in tons.	Quantity of stone in heading, in tons.	Total quantity of stone, in tons.	Price per ton.	Cost.
					Cents.	
A	920	51,753	5,700	57,453	75	$43,089.75
B	980	34,914	5,700	40,614	75	30,460.50
C	2,650	91,719	5,700	97,419	75	73,064.25
D	1,530	38,755	5,700	44,455	75	33,341.25
E	1,850	24,128	1,690	25,818	75	19,363.50
				265,759	75	199,319.25
Five beacons, each containing 47 cubic yards of split dimension stone, set in fine cement concrete, 235 cubic yards, at $12.75 per cubic yard						2,996.25
Total cost of jetties						202,315.50
Dredging channel near Jetty C, 400 feet wide, 22 feet deep at mean low water, will require the removal of 263,482 cubic yards, measured in situ, at 25 cents per cubic yard					$65,870.50	
Dredging channel between Jetties A and B, 400 feet wide, 22 feet deep at mean low water, will require the removal of 238,480 cubic yards, measured in situ, at 25 cents per cubic yard					59,620.00	
Total cost for dredging						125,490.50
Total cost for jetties and dredging						327,806.00
Add for contingencies and engineering expenses						37,194.00
Grand total cost						365,000.00

Very respectfully, your obedient servant,

A. C. BOTH,
Assistant Engineer.

Maj. JARED A. SMITH,
Corps of Engineers, U. S. A.

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APPENDIX B.

IMPROVEMENT OF RIVERS AND HARBORS IN MASSACHUSETTS.

REPORT OF LIEUTENANT-COLONEL GEORGE L. GILLESPIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Newburyport Harbor, Massachusetts.
2. Merrimac River, Massachusetts.
3. Ipswich River, Massachusetts.
4. Harbor of Refuge, Sandy Bay, Cape Ann, Massachusetts.
5. Gloucester Harbor, Massachusetts.
6. Lynn Harbor, Massachusetts.
7. Boston Harbor, Massachusetts.
8. Malden River, Massachusetts.
9. Hingham Harbor, Massachusetts.
10. Scituate Harbor, Massachusetts.
11. Plymouth Harbor, Massachusetts.
12. Provincetown Harbor, Massachusetts.

EXAMINATIONS AND SURVEYS.

13. Manchester Harbor, Massachusetts.
14. Winthrop Harbor, Massachusetts.
15. Duxbury Harbor, Massachusetts.
16. Wellfleet Harbor, Massachusetts.

UNITED STATES ENGINEER'S OFFICE,
Boston, Mass., July 10, 1888.

GENERAL: I have the honor to transmit herewith annual reports of the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

B 1.

IMPROVEMENT OF HARBOR AT NEWBURYPORT, MASSACHUSETTS.

Newburyport is situated on the south bank, 2½ miles approximately from the mouth of the Merrimac River. The river empties into the Atlantic Ocean midway between Cape Ann and Portsmouth, or about 30 miles a little east of north from Boston in a direct line.

The outlet of the river between Plum Island and Salisbury Point is 1,000 feet wide and 30 feet deep at mean low water. At a distance of nearly a mile outside lies a sandy bar thrown up by wave-action, through

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which, previous to the improvement, a channel variable in position, direction, and depth was maintained by the current of the river, increased by the tidal prism in a large interior basin due to a range of tides equaling 7.7 feet. For 1,000 feet outward from the gorge towards the crest of the bar the current was able to maintain a channel of navigable width and 18 feet deep at mean low water, and for a further distance of 1,500 feet a channel 12 feet deep. From the 18-foot contour on the inside to the same on the outside the distance was 4,000 feet, and between the 12-foot contours the distance was 3,000 feet. The depth on the crest of the bar was generally less than 7 feet at mean low water.

The object of the improvement is to create through the outer bar a channel 1,000 feet wide and at least 17 feet deep at mean low water, so that vessels may cross the bar and find a harbor at any stage of the tide, with as great draught as can reach Newburyport by the river at high tide.

The project submitted September 16, 1880, proposed two converging rubble-stone jetties, their outer ends parallel for 1,000 feet, and about the same distance apart; and the protection of the beach in their vicinity.

This was modified in 1882 so as to provide for the partial closing of Plum Island Basin with a timber dike about 800 feet long and 5½ feet above mean low water.

The direction of the south jetty, and the character of the shore projection were modified in 1883. The north jetty from Salisbury Beach is to be 4,000 feet long approximately, and the south jetty from Plum Island is to be 2,400 feet long approximately. Both are 15 feet wide on top, which is in a plane 12 feet above mean low water. The two jetties have slopes of 1 on 2 on the sea side, and of 1 on 1 on the harbor side.

A map showing the location of the jetties is published in the Annual Report of the Chief of Engineers for 1885. Their form and dimensions are shown in the Report for 1881. The location and details of construction of the dike are given in the Report for 1883. The estimated cost of the improvement was $375,000.

The total appropriations for this work to date have been $207,500. The amount expended to June 30, 1888, was $207,498.27.

During the fiscal year ending June 30, 1888, 3,443 tons of rubble-stone were deposited in the north jetty, under the contract of October 25, 1886, with Mr. Charles H. Edwards, at a cost of $2.23 per ton of 2,000 pounds. This contract was for 15,000 tons, more or less, and under it a total of 14,991 tons was deposited, thereby extending the full section of that jetty 390 feet. The contract was satisfactorily completed October 20, 1887.

A survey of the bar was made in August, 1887. The result indicated no material change of channel-depths on the bar; there was assuredly no deterioration, but rather a tendency to improvement.

The channel had straightened and moved southward slightly.

A survey was made in June, 1888. It showed a very decided advance in the condition of the improvement. The 12-foot channel had extended seaward 600 feet since the survey of 1887, and between the 12-foot contour inside and outside, embracing the bar, the distance had been reduced to 250 feet. The 9-foot contours crossed the bar and formed a channel of at least that depth 750 feet wide, with the exception of two small spots, whose depths were 8.5 and 7.6 feet, respectively.

Within this 9-foot channel three deeper channels cross the bar.

The two most southerly are direct and navigable. Each has a least depth of 10.7 feet; the most southerly is at least 150 feet wide; the other

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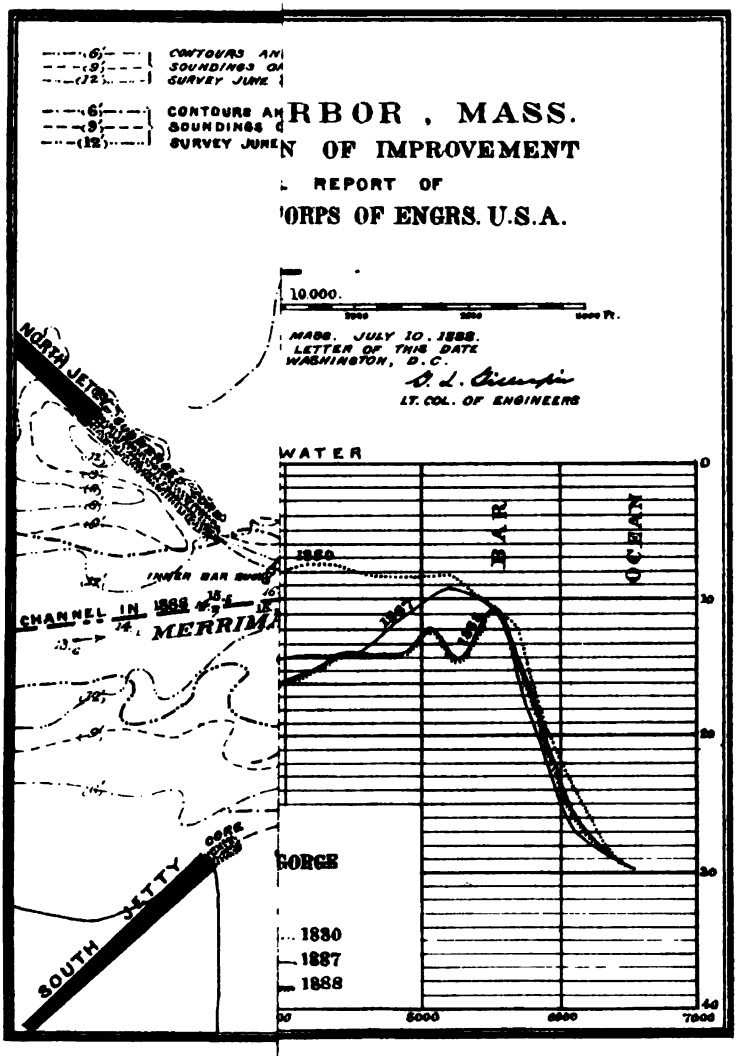

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is at least 200 feet wide; the third or northern deep-water channel has a least depth of 11.2 feet, but it is crooked and not over 100 feet wide.

The high-water line on the Salisbury Beach side of the entrance shows no essential change; on the Plum Island side, inside of the south jetty, it has advanced on an average 150 feet northward. This advance is apparently due to the increased shelter given by the extended north jetty, and to a straightening of the channel.

The spring freshet in the river, as shown by notes furnished by Mr. Hiram F. Mills, engineer of the Essex Company at Lawrence, Mass., was not of an average height, but was of an unusual duration; the river was "high" for more than three months, and to this is probably due the very large increase of scour on the bar. A comparative chart that shows the condition of the bar, June, 1887, and June, 1888, accompanies this report.

The condition of the improvement on June 30, 1888, was as follows: The north jetty had been completed for a length of 1,930 feet, and in addition 745 feet was partly completed; the south jetty had been completed 1,077 feet, and partly completed for an additional distance of 223 feet, and its shore end protected by a durable sand catch.

The dike was completed as far as was prudent at that time for its safety. It was 817 feet long, and 5½ feet high above mean low water, except that near its center, a weir was left 150 feet long and 2 feet deep at mean low water.

The channel through the bar was at least 200 feet wide and 10.7 feet deep at mean low water.

No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill for the fiscal year ending June 30, 1889, contains an item of $25,000 for continuing this improvement, and if this amount should be appropriated it will provide for the delivery of 10,000 tons of stone towards the extension of the two jetties. Estimating that the appropriation of $25,000 will be made very soon after the close of the present fiscal year, there will be required in addition for the completion of the project the sum of $142,500, all of which it is recommended should be appropriated for the fiscal year ending June 30, 1890, for application in extending the two jetties to the full projected length. The improvement is in a very encouraging condition, and should be pushed to completion with the least delay practicable. The advantages to be derived from the completion of the project are the deepening and widening of the channel across the bar, thereby affording a harbor of refuge on the inside of Salisbury Beach, and also affording easy access at high stage to the wharves at Newburyport for vessels drawing 17 feet approximately.

This work is located in the collection district of Newburyport, Mass., of which Newburyport is the port of entry. The nearest light-house is on Plum Island, at the entrance of the harbor.

The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs for Newburyport, Mass.

Money statement.

July 1, 1887, amount available	$17,623.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17,622.07
July 1, 1888, balance available	1.73
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,001.73

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Amount (estimated) required for completion of existing project.....$142,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 142,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Shipping.	Vessels.	Tonnage.
Foreign arrivals	29	3,481
Foreign clearances	46	6,604
Coastwise arrivals	342	89,382

Received from customs	$2,782.03
Received from tonnage tax	93.51
Total	2,875.54

IMPORTS.

Coal	tons..	5,098
Lumber	feet..	265,000
Shingles		352,000
Potatoes	bushels..	7,346
Vegetables	do....	300
Eggs	dozen..	300
Coal received by coastwise arrivals	tons..	175,000

B 2.

IMPROVEMENT OF MERRIMAC RIVER, MASSACHUSETTS.

The mouth of the Merrimac River is 15 miles northwest from Cape Ann, Massachusetts. Tide-water extends up it a distance of 19 miles, or to foot of the "Upper Falls," 1½ miles above Haverhill, Mass.

Seven incorporated cities and the largest mills in New England are directly interested in its improvement. Before improvement the channel was narrow and crooked, and much obstructed by ledges, bowlders, and shoals. At mean low water vessels drawing not to exceed 7 feet could enter the river and proceed to South Amesbury, 9 miles from the mouth. The sea bar at the mouth of the river has been improved under specific appropriations for improvement of Newburyport Harbor, while many sunken rocks and wrecks of piers and vessels lying inside the bar have been removed by general appropriations for the improvement of the river.

The object of the Merrimac River improvement is to straighten, widen, and deepen the natural channel from the bar to the head of tide-water of the upper falls of a group known as Mitchell's Falls.

The rise or fall of the tide at the mouth is 7.7 feet, at Haverhill Bridge, 4 feet.

No plan of the river above Newburyport has been published in the Reports of the Chief of Engineers.

The project originally adopted in 1870 proposed to remove obstructions from the Upper and Lower Mitchell's Falls, and to remove the Gangway rock and the "Boilers" in Newburyport Harbor. The cost was estimated to be $69,025. This project was modified in 1874 so as to include the removal of rocks in and near the draw of the bridge at

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Deer Island, 2 miles above Newburyport, and Rock's Bridge, and at Little Currier's Shoal, East Haverhill, so that the channel should have the following depths at ordinary high-water stages of the river: From the mouth to Deer Island Bridge (5 miles), 16½ feet; from Deer Island Bridge to Haverhill Bridge (12½ miles), 12 feet; thence to the foot of Mitchell's Falls, Hazeltine Rapids (1½ miles), 10 feet; through Mitchell's Falls to the head of the Upper Falls (2½ miles), not less than 4½ feet, when the mill-water at Lawrence is running.

This revised project was estimated to cost $147,000.

The total appropriations to date have been $170,500.

The total expenditures to June 30, 1888, were $170,498.43.

During the fiscal year gauges to establish high-water plane were established at Haverhill Bridge and at Newburyport Bridge, and the height of the water recorded hourly during the spring freshet of 1888. These records, with similar data furnished by Mr. Hiram F. Mills, hydraulic engineer of the Essex Company, at Lawrence, Mass., will fix the high-water-grade line of the river from the dam at Lawrence to its mouth, in accordance with circular letter of the Engineer Department, dated April 25, 1888.

No other operations were in progress. The condition of the improvement on June 30, 1888, was as follows:

The river channel had been improved in accordance with the modified project of 1874, with the exception of the removal of the "Boilers," upon which no work had been done.

The excess of expenditure over the estimate is due to the removal of rocks and other obstructions that were unknown, or whose removal were not contemplated when the estimate was made, and by the expense of necessary surveys and examinations not provided for in the estimate.

The project, as modified in 1874, has been completed with the exception of the removal of the "Boilers." But from 1883–'86, additional improvements were recommended, as follows:

For that part of the river below head of Mitchell's Falls:

1. To remove sunken rocks and shoals from Mitchell's Falls	$1,500
2. To remove "The Boilers" to a depth of 5 feet at mean low water, 350 cubic yards, at $25	8,750
Contingencies	1,250
Total	11,500

To extend the improvement so that the same depth of water as is now obtained through Mitchell's Falls can be carried to Lawrence (a distance of 5 miles from the head of the Falls) was, in 1882, estimated to cost for dredging through Gage's Shoal and Andover Bar, and removing bowlders and ledges, $11,000.

The improved channel is in good order, and meets all existing demands of commerce. No appropriation is recommended for the fiscal year ending June 30, 1890.

This work is located in the collection district of Newburyport, Mass., of which Newburyport is the nearest port of entry. The nearest light-house is the Plum Island Lights and the Newburyport Upper Harbor Lights.

Commercial statistics are included in statement for Newburyport Harbor.

Money statement.

July 1, 1887, amount available		$290.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$282.47	
July 1, 1888, outstanding liabilities	6.00	
		288.47
July 1, 1888, balance available		1.57

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B 3.

IMPROVEMENT OF IPSWICH RIVER, MASSACHUSETTS.

Ipswich River empties into Plum Island Sound, 9 miles south of Newburyport, Mass., and at the same distance west of Cape Ann. The head of navigation is 3 miles above the mouth.

The entrance of Plum Island Sound is 2 miles east of the mouth of the river. Six feet depth at mean low water can be carried over the bar at the entrance to the sound, and between the bar and the mouth of the river there is a good anchorage, with from 3 to 5 fathoms of water.

Before improvement the channel of the river from its mouth to "Barras Turn," a distance of 2 miles, was at least 60 feet wide and 4 feet deep at mean low water. From "Barras Turn" to the town wharves, a distance of 1 mile, the channel was narrow and crooked, and had at some places but $1\frac{1}{2}$ feet depth at mean low water. The mean rise or fall of the tide is $8\frac{4}{10}$ feet.

The original project for improvement was submitted December 6, 1875. It proposed a channel 60 feet wide and 4 feet deep, mean low water, from "Barras Turn" to the town wharves, at an estimated cost of $25,000.

On November 5, 1883, the original project was divided into three partial projects:

1. The removal of the ledges at Heard's Point, and opposite Nabby's Point, to a depth of 2 feet at mean low water, to open a navigable channel of that depth, at a cost of $15,900.

2. To dredge the shoals at "Labor in Vain" and "The Shoals," so as to open a channel 4 feet deep, at mean low water, and 60 feet wide, at a cost of $2,200.

3. To straighten the channel by making a cut across "Barras Turns," and to build a jetty to close the old channel at a cost of $6,900. In the Annual Report of 1887 it was recommended that the general project be modified, by limiting the present improvement to opening a channel, 60 feet wide and 4 feet deep through "The Shoals" and "Labor in Vain" and extending it to the "Deep Hole," opposite the town wharves.

A chart showing this limited project was published in the Report of the Chief of Engineers for 1887.

The amount which has been appropriated for this improvement to date is $2,500 by the act of August 5, 1886.

The amount expended to June 30, 1888, was $2,500.

No active operations have been in progress during the fiscal year ending June 30, 1888, from want of funds. The condition of the improvements June 30, 1888, was as follows: A channel 4 feet deep at mean low water had been dredged 60 feet wide at "Labor in Vain," and 40 feet wide at "The Shoals."

The full projected width of the channel at "The Shoals" had not been obtained for the reason that logs and bowlders were uncovered by the dredging, and the increased expense of their removal proportionally reduced the amount applicable to dredging.

No appropriation was made for the fiscal year ending June 30, 1888.

The river and harbor bill for the year ending June 30, 1889, contains an item of $2,500 for continuing the improvement, and if appropriated that sum will be applied towards enlarging the cut through "The Shoals" and connecting the "Deep Hole," opposite Glover's Wharf, with the improved channel below Heard's Point, by a cut 250 feet long, 60 feet wide, and 4 feet deep. When this work is done the amount re-

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quired to complete the original project will be $20,000; but it is not considered necessary to make recommendations for additional improvements until the commerce of the river has increased beyond its present volume. No recommendation is therefore made for continuing the improvement for the fiscal year ending June 30, 1890.

Ipswich River is in the collection district of Newburyport, Mass. The nearest light-house is the Ipswich Light, on Castle Neck, about 1½ miles southeast from the mouth of the river.

Commercial statistics included in Newburyport Harbor.

Money statement.

July 1, 1887, amount available	$246.79
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	246.79
Amount appropriated by act of August 11, 1888	2,500.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

B 4.

HARBOR OF REFUGE, SANDY BAY, CAPE ANN, MASSACHUSETTS.

Sandy Bay is situated at the northeastern extremity of the promontory of Cape Ann, which forms the northern limit of Massachusetts Bay. The shore-lines of the bay form a little less than a right angle, and their directions are nearly north and south and east and west. The rocky island of Straitsmouth forms the eastern extremity of one shore-line, and the steep headland of Andrew's Point the northern end of the other. Following the line of the proposed breakwater, the bay is 2¾ miles wide, and it has a depth of 2 miles approximately.

The bay on the land side is perfectly protected by steep high hills, but it fronts the northeast, and is open to the full force of the violent northerly and easterly gales of this coast. The great seas of the ocean are broken, however, in a degree by the sunken rocky ledges called Avery's ledge, the Dry and Little Salvages, the Flat Ground and Abner's ledge, which are directly at the mouth of the bay. Inside these entrance ledges the bay is entirely unobstructed, and has an average depth of 50 feet at mean low water.

A plan of the bay showing the proposed breakwater was published in the Annual Report of the Chief of Engineers for 1886, page 582.

The project for improvement was submitted in 1884. It proposes a continuous breakwater 9,000 feet long, divided into two branches; one starts at Avery's ledge and runs in a direction a little west of north to Abner's ledge, a distance of 3,600 feet; the other extends 5,420 feet from Abner's ledge, in a northeasterly direction, and terminates at the 83 feet contour off Andrew's Point. The axis of the proposed breakwater is approximately at the inner edge of the ledges at the entrance of the bay, and about a mile inside the Salvages and Flat Ground, which will receive the first shock of easterly storm waves.

The southern entrance to the harbor lies between Straitsmouth Island and Avery's ledge, and is 1,800 feet wide, and at least 30 feet deep.

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The northern entrance, near Andrew's Point, is 2,700 feet wide, and 80 feet deep. They are so located with reference to each other that vessels can enter and leave the harbor without any wind.

The harbor formed by the breakwater covers an anchorage of 1,377 acres, in which the depth exceeds 24 feet at mean low stage. The theoretical anchorage capacity is fifty-five hundred vessels.

The breakwater will be formed to the level of 22 feet below low water, of a mound of broken stone, 40 feet wide at top, above which a masonry wall has been suggested, whose crest shall be 15 feet wide and 8 feet above extreme high water. The detailed plan for the construction of the masonry wall has not been definitely adopted, and operations have been confined to the construction of the rubble-stone mound, or substructure of the breakwater. This is effected by dropping stone from vessels and self-dumping scows along the axis of the breakwater, extending to the eastward and westward, a distance of 20 feet approximately. The axis is indicated by an iron spindle on Avery's ledge, when in range with the south light-house on Thatcher's Island; cross-ranges are established by iron pipes let into the rocks on the Dry and Little Salvages, which mark points at intervals of 100 feet from the spindle (initial point) on Avery's ledge. The estimated cost of the improvement is $5,000,000, to which must be added $2,500,000 for buoyage, lighting, and defense of the harbor.

These estimates are based upon consecutive annual appropriations of not less than 10 per cent. of the original estimates of cost. Should operations be suspended at any time from want of funds, or annual appropriations be reduced to small sums for a series of years, the expenses for the final construction will be proportionally increased.

The amount which has been appropriated to date is $200,000.

The total amount expended to June 30, 1888, inclusive of outstanding liabilities, was $194,125.24.

During the fiscal year ending June 30, 1888, 83,935 tons of rubble-stone, at 71 cents per ton of 2,000 pounds, were deposited under a contract dated October 21, 1886, with the Rockport and Pigeon Hill Granite companies. Operations under this contract were commenced March 21, 1887, and were satisfactorily completed June 23, 1888, 114,931 tons having been deposited by the contractors. This stone was dumped between cross-ranges 1540 and 2340, or at corresponding feet from the initial point. From the nature of the work, the top of the mound is somewhat irregular, and the depth of water over it at low tide varies from 18 to 23 feet. A careful survey of the mound is now in progress, and the results will be compared with previous surveys by which deductions may be drawn as to settlement and wave action, if any such changes have taken place. The spindle marking the initial point on Avery's ledge was broken off by a vessel drifting over it in June, 1887. Every possible method was adopted to remove the stump of the spindle from the hole in the ledge, but unsuccessfully, and the attempt was abandoned.

In July, 1887, the drilling of a new spindle hole was begun on Avery's ledge, and was satisfactorily completed early in September, 1887, in time to receive a new spindle which had been ordered. This new spindle in turn was prostrated during an easterly gale in March, 1888, the fracture occurring inside the hole near the surface of the rock.

The stump was extracted, and the frustum reforged and replaced March 26, 1888. The destruction of this important spindle is liable to occur at any time, and a spare hole in the ledge and a duplicate spindle should always be available while operations are in progress to prevent serious delays, at least until some more efficient method of mark-

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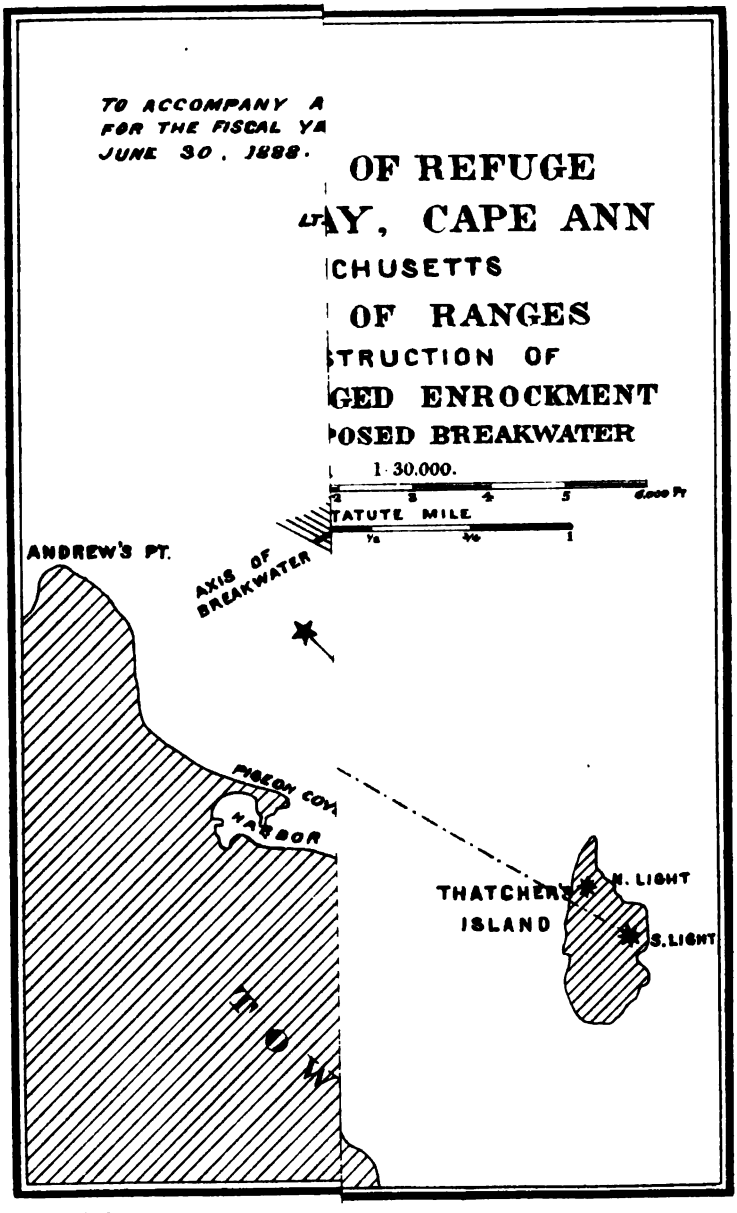

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ing the initial point has been adopted. The pipes on the Salvages, indicating the cross-ranges, are frequently swept away; but the cost and trouble of replacing them are slight, and the loss causes no important delay to the work.

Sealed proposals were invited by public advertisement, according to law, on December 2, 1887, for the hire of a steam-launch to be used by the inspector in overseeing the dumpings. One bid, presented by Mr. F. Scripture, was received and opened January 2, 1888, and the price bid of $125 per month was accepted and a formal written contract, dated January 13, 1888, was executed for this service. This contract was closed June 30, 1888.

The condition of the improvement on June 30, 1888, is as follows:

A total of 242,934 tons of rubble-stone had been deposited between cross ranges 140 and 2340, thus essentially completing 2,200 running feet of the substructure of the breakwater. The ranges used in the work were in position and in good order.

The funds available July 1, 1888, will be expended in completing the survey of the mound now in progress, and in preparing drawings, estimates, etc., therefrom.

No appropriation was made for the fiscal year ending June 30, 1888.

The river and harbor bill for the fiscal year ending June 30,1889, contains an item of $100,000 for continuing the improvement, and if this amount should be appropriated by the present session of Congress, it will be applied towards extending the rubble mound 800 feet towards Abner's ledge, the drilling of a new spindle hole on Avery's ledge, and in the purchase of a duplicate spindle. On completion of this work the amount required to complete the project will be $4,700,000, approximately. An appropriation of $200,000 is recommended for the fiscal year ending June 30, 1890, and if appropriated will be applied towards the further extension of the substructure of the breakwater in the direction of Abner's ledge.

The prospective benefits to commerce and navigation by the construction of this harbor of refuge are increased safety to life and property, and a consequent reduction in freights and insurance.

Sandy Bay is situated in the collection district of Gloucester, Mass.

The nearest light-house is Straits-mouth Light, situated on Straits-mouth island, at the southern entrance of the bay.

The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs at Gloucester, Mass.

Money statement.

July 1, 1887, amount available		$75,916.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$58,571.09	
July 1, 1888, outstanding liabilities	11,470.24	
		70,041.33
July 1, 1888, balance available		5,874.76
Amount appropriated by act of August 11, 1888		100,000.00
Amount available for fiscal year ending June 30, 1889		105,874.76
Amount (estimated) required for completion of existing project		4,700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals for removing remains of iron spindle from Avery Ledge, Sandy Bay, Mass., and enlarging present hole to 8 inches in diameter, opened July 13, 1887, by Lieut. Col. G. L. Gillespie, Corps of Engineers.

No.	Names and residence of bidders.	Amount bid for removing the spindle and enlarging hole.
1	George W. Townsend, Boston, Mass	$1,500
2	George F. Runyan, Boston, Mass	1,600
3	W. D. Duncan & Nickerson, Boston, Mass	2,500
4	Boynton Bros., Boston, Mass	*650

* Lowest bid for drilling a new hole.

Contract was awarded to Boynton Bros., with the approval of the Chief of Engineers.

Abstract of proposals for furnishing a steam-launch during the year 1888 for service at Sandy Bay, Mass., opened January 2, 1888, by Lieut. Col. G. L. Gillespie, Corps of Engineers.

No.	Name and residence of bidder.	Price bid per month.	Remarks.
1	Frank Scripture, Rockport, Mass	$125	Only bid received.

Contract was awarded to Mr. Frank Scripture, with the approval of the Chief of Engineers.

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Vessels hailing from Rockport, Mass 48
Tonnage 1,950

Five vessels entered the port with cargoes consisting of fire-wood and eggs; value, $650; no duties collected.

B 5.

IMPROVEMENT OF GLOUCESTER HARBOR, MASSACHUSETTS.

This is the most important harbor between Boston and Portland, and is the principal resort for all New England fishing vessels. It is situated at the southeastern extremity of Cape Ann, 20 miles northeast from Boston. It is easily entered when the dangerous easterly storms of this coast occur, and provides a secure ample shelter for all classes of vessels except from south winds, and from these a moderate extent of protected anchorage is afforded in the inner harbor.

It contains in the outer roadstead the inner harbor, and in the channel connecting them sufficient deep water for the most liberal demands of commerce; but the inner harbor and channel are obstructed by bowlders, ledges, and shoals dangerous and inconvenient to shipping, and the outer harbor or roadstead is open to the action of all southerly winds.

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A plan of the harbor was published in the Report of the Chief of Engineers for 1887, page 506.

The first project formed for improvement was submitted by the local engineer January 20, 1871, and was based on the survey ordered by the act of July 11, 1870. (Report of the Chief of Engineers, 1871, page 869.)

This project proposed the removal of certain bowlders from the inner harbor at a cost of $10,606.20, and the construction of a breakwater from Eastern Point over Dog Bar to Round Rock Shoal, at an estimated cost of $494,148.65.

On November 19, 1884, Major Raymond, Corps of Engineers, by order of the special Board of Engineers that was considering the subject of the Sandy Bay breakwater, submitted a project for two breakwaters at the entrance of Gloucester Harbor, one to cost $752,000, on essentially the same site as that proposed in 1871, and a supplementary one through Norman's Woe Rock, to cost $607,000. This project and estimate are published in the Chief of Engineer's Report for 1885, page 534.

On January 20, 1885, it was recommended, in accordance with act of July 5, 1884, that a survey of the inner harbor and of the reef off Muscle Point be made, and that Babson's Ledge be removed to 21 feet at mean low water. (Report Chief of Engineers, 1885, page 541.)

In the annual report for this harbor for 1887 a general project for its improvement was submitted, based on the survey ordered by act of Congress approved August 5, 1886. (Chief of Engineer Report, 1887, page 500.)

This project provided for the removal from the inner harbor of 101½ cubic yards of rock known to exist, and of 216,000 cubic yards, scow measurement, of material, at an estimated cost of $65,000, and for the construction of the breakwater, recommended in the project of 1884, that extends from Eastern Point to Round Rock Shoal, at an estimated cost of $752,000.

The total appropriations for this harbor to date have been $15,000.

The amount expended to June 30, 1888, was $15,000.

During the fiscal year ending June 30, 1888, the chart of the survey provided for in the act of August 5, 1886, was completed, and the operations under that part of the act requiring the partial removal of Babson's Ledge were as follows:

The survey showed that the ledge was very much more extensive than had been supposed; that instead of a few hundred cubic yards, it contained 5,000 to the plane of 21 feet below mean low water. The funds specifically appropriated would only suffice to reduce the ledge to 14 feet below mean low water. This work was recommended July 27, and approved July 30, 1887. Specifications were prepared, and sealed proposals invited, according to law, by public advertisement dated July 27, 1887. Three bids were received and opened August 30, 1887; the highest was $59, the lowest $14.75 per cubic yard. A contract approved by the Chief of Engineers was entered into with Messrs. Duncan & Nickerson, the lowest bidders, and the ledge was succesfully reduced as proposed, during the months of September, October, and November, 1887, to the depth of 14 feet mean low water by the removal of 149.94 cubic yards of rock.

The condition of the improvement June 30, 1888, was as follows:

Clam Rock had been reduced from 1 foot to 9½ feet at mean low water; Pinnacle Rock from 8½ feet to 16½ feet, mean low water; rock off Pew's Wharf from 2 to 5 feet mean low water; rocks off of J. Friend's Wharf, from 13 to 17 feet mean low water. All the above were reduced

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to the level of the surrounding bottoms. Babson's Ledge from 11 to 14 feet mean low water, or as far as the funds provided sufficed, and it is now believed to be no further obstruction to commerce if kept properly bouyed.

No work had been done on the breakwater.

No appropriation was made for the fiscal year ending June 30, 1888.

The river and harbor bill for the fiscal year ending June 30, 1889, contains an item of $10,000 for the improvement of Gloucester Harbor, in partial execution of the project of 1887 (Annual Report Chief of Engineers, 1887, pages 500–504), and if appropriated will be applied in dredging Harbor Cove and removing ledges and bowlders obstructing the approach to the wharves between Harbor Cove and Pew's Wharf.

The value of this harbor in its relation to the general commerce of the coast, and especially to the fishing industry, is given in detail in the Annual Report for 1887, to which reference is invited.

For the fiscal year ending June 30, 1890, an appropriation of $305,000 is recommended, in partial execution of the project of 1887; $55,000 to be applied to the completion of the dredging of Harbor Cove, and of the removal of ledges and bowlders between that basin and Pew's Wharf, and $250,000 for beginning the breakwater proposed to be built from Eastern Point over Dog Bar to Round Rock Shoal, for the purpose of protecting the outer harbor against southeasterly storms.

The vested interests at this harbor represent directly and indirectly the large sum of $143,875,800. It is stated authentically that seven thousand vessels of all classes visit the port annually.

The prospective advantages to commerce by the completion of the improvement are greater facilities and safety in the movement of vessels in the harbor, and a more secure anchorage for vessels seeking protection from southerly gales.

Gloucester Harbor is in the collection district of Gloucester, Mass., of which Gloucester is the port of entry. The nearest light-houses are Ten Pound Island light, in the harbor, and Eastern Point light, at the entrance of the harbor.

The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs at Gloucester, Mass.

Money statement.

July 1, 1887, amount available	$3,003.29
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,003.29
Amount appropriated by act of August 11, 1888	10,000.00
Amount (estimated) required for completion of existing project	807,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	305,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for removing Babson's Ledge, Gloucester Harbor, Mass., opened August 30, 1887, by Lieut. Col. G. L. Gillespie, Corps of Engineers.

No.	Names of bidders.	Price bid for removal of rock per cubic yard.
1	William David Duncan and James Ephraim Nickerson	*$14.75
2	Thomas Symonds	21.00
3	Charles H. Edwards	59.00

*Lowest bid.

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Award of contract was made to Messrs. Duncan & Nickerson, with the approval of the Chief of Engineers.

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Fishing vessels	414
Coasting	47
Foreign trade	9
Yachts	3
Total	473
Tonnage.....tons..	31,194
Domestic arrivals	91
Domestic clearances	99
Foreign arrivals	68
Foreign clearances	53
Coastwise arrivals	29
Coastwise clearances	60
Value of imports	$140,322
Duty on imports collected	12,912

B 6.

IMPROVEMENT OF LYNN HARBOR, MASSACHUSETTS.

Lynn Harbor is situated 9 miles northeast from Boston. It is 1 by 2 miles, approximately, in extent, the greater part of which is dry at low water. It is protected on the north and west by the main land, and on the east by Nahant Beach, and its entrance 2 miles wide into Massachusetts Bay is on the south side.

Before improvement three narrow and crooked channels of approach to the wharves existed, in each of which there was about 6 feet depth at mean low water. The mean rise or fall of the tide is $9\frac{3}{10}$ feet.

The western channel leads to the "Point of Pines" and the mouth of Saugus River. The main ship-channel is entered between "White" and "Lobster" rocks, and connects about 3,600 feet northward with the "Black Rock" channel, which is the most eastern near Nahant Beach.

The project for improvement was adopted in 1884. It provides for the excavation of a channel 200 feet wide and 10 feet deep at mean low water, from a point near and east of the "White Rocks" to deep water opposite Little Nahant, a distance of 3,610 feet. This is called the "outer" improved channel, and is merely a rectification and deepening of the Main Ship-channel. The combined Main Ship and Black Rock channels are sufficient for the purposes of commerce for the next 2,500 feet. Then commences the "inner" improved channel, which is projected 6,450 feet long, 200 feet wide, and 10 feet deep at mean low water. It extends from deep water opposite "Sand Point" to the harbor commissioners' line, and follows very closely in direction the extension of the united Main Ship and Black Rock channels.

It is supposed that the inner channel will need to be dredged occasionally to maintain its width and depth; but a training-wall about 6,000 feet long has been proposed to aid in keeping the outer channel open, if experience shall show it to be necessary.

This wall is to start from the shore at "Little Nahant," and is to cross the Black Rock Channel; its outer portion is to be parallel to the outer improved channel.

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The cost of this project was originally estimated to be $145,000. This estimate was revised in 1885, and then made $157,000. This excess of $12,000 was caused by an increased amount of dredging found to be necessary during the progress of the work, to round off the corners of the natural channel at its junctions with the dredged channel; to provide flatter slopes to the sides of the cut than was originally designed; and also to provide funds for the necessary surveys during the progress of the work.

A plan of the harbor, showing the projected improvement, was published in the Annual Report of the Chief of Engineers for 1884, Part I, page 532. The amount expended to June 30, 1888, was $65,962.60.

At this date the outer channel had been completed, as proposed, 3,610 feet long, 200 feet wide, 10 feet deep, and the inner channel had been improved 6,450 feet long and 10 feet deep, with a width limited to 150 feet, or 50 feet less than the project calls for.

A survey of the improved channels was made during the latter part of June, 1888, and it was found that the improvement showed no serious deterioration, and was essentially as at the date of the last Annual Report.

No other operations were in progress during the fiscal year.

No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill for the fiscal year ending June 30, 1889, contains an item of $10,000 for the improvement of this harbor, and if this sum should be appropriated part of it may be applied in the channel leading to the Point of Pines, and the residue in extending the improved inner channel westward 50 feet wide, to the basin, inclosed by the wharves of the city of Lynn, beyond the line established by the dock commissioners. This extension will be 1,200 feet long, and if it should be made of the same width and depth as the project provides for the inner channel, 100,000 cubic yards of material will have to be excavated, in addition to the original estimate, at a cost of $25,000, making the total estimate of cost for the proposed improvement $182,000 (inclusive of training-wall, estimated to cost $66,500).

The total amount appropriated for this work to date is $66,000. It is not necessary at this time to enter upon the construction of the training-wall for the outer channel. The inner channel should be first widened 50 feet to give it the full projected width, 200 feet, and then extended with this full width to the inner basin. To effect this will require the removal of 210,000 cubic yards of material, at an estimated cost of $49,500.

An appropriation of $30,000 is recommended for the fiscal year ending June 30, 1890, of which $24,000 will be applied in widening the inner channel 50 feet, and $6,000 in widening the northward extension 50 feet, so that the channel leading to the inner basin may be improved to a width of 100 feet, with 10 feet depth at mean low water.

Lynn is a port of entry in the collection district of Marblehead, Mass. The nearest light-house is Egg Rock (Nahant) Light, 3 miles distant.

The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs for the port of Marblehead, Mass.:

Money statement.

July 1, 1887, amount available	$566.86
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	529.46
July 1, 1888, balance available	37.40
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,037.40

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Amount (estimated) required for completion of existing project.....$172,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

LETTER FROM MR. FRANCIS E. PEDRICK.

CUSTOM-HOUSE, COLLECTOR'S OFFICE,
Marblehead, Mass., July 9, 1888.

I inclose herewith information as per request of yours of the 26th instant. There has been a marked increase in the commerce of Lynn during the past year, and masters of vessels express great satisfaction at the recent improvements; but the work should be continued in order that the commerce may increase with the demands of the above growing city.

Very respectfully, yours, etc.,

FRANCIS E. PEDRICK.

Lieutenant-Colonel GILLESPIE, U. S. A.

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Revenue collected during the fiscal year ending June 30, 1888, $6,789.52.

Shipping.	Vessels.	Tonnage.
Foreign entrances	41	4,392
Foreign clearances	49	6,088
Coastwise	556	90,843

Total value of merchandise, $851,950, including the following articles:

Coal	$649,000
Lumber	99,000
Lime and cement	39,600
Stone and sand	16,500
Fire-wood	3,850
Hay, tiles, pipes, stone, potatoes and other vegetables, etc	44,000
Total	851,950

B 7.

IMPROVEMENT OF BOSTON HARBOR, MASSACHUSETTS.

Boston Harbor consists essentially of an inner and an outer harbor, united by a deep water-way, and each accessible from the sea by a distinct channel, widening into a deep and spacious roadstead.

1. *Inner harbor.*—This harbor lies to the north and westward of Long Island, and has deep water and a good anchorage in the President Roads, seaward of Lower Middle Bar, and also near the city westward of Upper Middle Bar.

Four rivers discharge their waters into this basin: the Charles, Mystic, and Chelsea rivers from the north, and the Neponset from the south. The direct entrance from the sea is by Broad Sound,

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2. *Outer harbor.*—This harbor lies to the southward of Long Island and has a fine anchorage in Nantasket Roads, as well as in Hingham Bay, a well-sheltered harbor southeast of Paddock Island. It connects with the inner harbor by the main ship-channel through the "Narrows," and by secondary channels east and west of Long Island.

It is reached from the sea by Nantasket Roads, which lie south of George's and Great Brewster islands, and is marked at the sea entrance by Boston Light.

Both the inner and outer harbors are subdivided into several minor harbors, and contain many islands, which shelter the anchorages from winds and storm waves.

The range of tides at the navy-yard is 9.8 feet, and at the entrance to the outer harbor 9.4 feet.

A sketch of the harbor was printed in the Annual Report of the Chief of Engineers for the year 1883, page 454.

The object of the improvement is, first, to *preserve* the harbor by protecting the islands and headlands, and, second, to *improve* it by widening, deepening, and straightening the channels.

The projects adopted for this purpose since 1866 have been mainly in accordance with the recommendations of the United States commissioners, whose labors terminated during that year.

The works of *preservation* consist of sea-walls, aprons, jetties, etc., which protect the shores of the islands and headlands, prevent additional wash into the channels, control the tidal scour, and preserve the full height of anchorage shelter for vessels in the roadsteads.

The works of *improvement* have been by dredging and blasting.

The amount which has been appropriated for this improvement to date is $1,663,750.

The total amount expended to June 30, 1888, was $1,654,020.74 (inclusive outstanding liabilities).

WORKS OF PRESERVATION.

Point Allerton.—This headland, at the southeasterly entrance of the harbor, is protected by a granite sea-wall 1,202 feet in length. It was completed in 1873. Its concrete foundation, for a distance of 1,005 feet, is protected by an apron and eight short jetties of granite rubble-stone. No work was done on it during the fiscal year. Its condition June 30, 1888, is as follows: The wall is generally in good order, although some of its joints should be repointed. The bluff protected by this wall is not fully covered from storm action, and the sea-wall should be extended westward for a distance of at least 150 feet, and the foundation of this extension should be protected with rip-rap.

This is estimated to cost $15,000.

Great Brewster Island.—This island is on the north side of the Main Ship-channel, near the entrance. It is protected by a granite sea-wall 2,840 feet long, which was completed in 1869. During the fiscal year ending June 30, 1888, 617 running feet of the coping course were reset by hired labor at a cost of $2,167.06. On June 30, 1888, the wall was in good order, although many of the joints should be repointed.

George's Island.—Its northern and eastern shores are protected by a granite sea-wall 2,150 feet long. West of this wall a riprap improvement extends for 450 feet, and south of it another 600 feet long. The sea-wall and southern riprap were built about 1835. The western riprap was built in 1884–'85. No work was done during the fiscal year. Its condition on June 30, 1888, was as follows: One coping stone of the

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sea-wall was thrown from the wall and eight others were loosened by storm action; they will require resetting. This work is estimated to cost $300. The unprotected western shore-line of the island, in front of the Government buildings, was considerably abraded; the high-water line had been moved back in places nearly 25 feet. This shore-line should be protected by a light sea-wall, 1,400 feet long, at a cost of $35,000, or at least by a stone apron, at a cost of $10,000.

Lovell's Island.—The western shore of this island is protected by a rubble-stone apron 975 feet long, built in 1873 and repaired and extended in 1884; the northern shore is covered by a granite sea-wall 750 feet long, built in 1843, and the eastern shore is protected by a granite sea-wall 800 feet long, built in 1869 and repaired in 1879 and in 1886, and by two rubble-stone aprons, one between the northern and eastern sea-walls 1,440 feet long and the other south of the east sea-wall 1,330 feet long. No operations were in progress during the fiscal year. The condition of the works June 30, 1888, was as follows: The sea-walls and the riprap on the eastern shore were in good order; the western-shore riprap had been undermined in places, and had fallen down, but it needed no immediate repairs.

Gallop's Island.—The western, northern, and eastern shores of this island are protected by a granite sea-wall 1,785½ feet long, completed in 1871, and by a rubble-stone apron completed in 1884, 3,050 feet long, which also covers the foundation of the sea-wall. No operations were in progress during the fiscal year, and at its close, June 30, 1888, the wall and riprap were in good order. To more completely protect the northwestern bluff of this island, which has been very seriously abraded by storms, especially during the past winter, the sea-wall should be extended about 300 feet to the southward. This it is estimated will cost $15,000.

Deer Island.—The three prominent bluffs of this island are protected by granite sea-walls originally built about 1827. The north head wall is 1,740 feet long; the middle head wall is 840 feet, and the south head wall is 380 feet long. In 1865 and 1869 these walls were partly rebuilt, and in the weakest places were backed with concrete. They were all originally built dry, and from time to time have required repairs. During the fiscal year some of the joints of the south and middle head wall were repainted, at a cost of $426.45.

On June 30, 1888, the south and middle head walls were in fair order; some repairs to the north head wall were needed, a few feet of the coping course have been loosened, and part of the paving in rear of the walls needs resetting.

Long Island.—The north head of this island is protected by a granite sea-wall 2,081¾ feet long, completed in 1874. Part of the foundation of the sea-wall, and of the beach at both of its ends are protected by a rubble-stone apron, aggregating 1,375 feet in length. This apron was built in 1874 and extended in 1884. No operations were in progress during the fiscal year. On June 30, 1888, the wall needed to be repointed in places, the riprap was in fair order and should be extended about 250 feet to more fully protect the southeastern shore; these repairs and extensions are estimated to cost $3,000.

Rainsford Island.—The north head of this island is protected by a dry granite sea-wall 1,500 feet long, originally built about 1840, and extensively repaired in 1884–'85.

No work was done during the year, and on June 30, 1888, the wall was in good order and needed no repairs.

Castle Island.—The north and part of the east and west shores of this

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island are protected by a dry granite sea-wall 3,300 feet long, built in 1835. A light riprap extends along the east shore 300 feet from the end of the sea-wall; this was built in 1865.

No work was done during the fiscal year, and on June 30, 1888, the riprap was in good order; the sea-wall needed repairs on the north face, a short distance west of the wharf, where the foundation has been undermined and the wall has settled. About 100 running feet of the wall has been thus injured, and this length of wall needs to be taken down and rebuilt, at a cost of about $1,000.

Governor's Island.—The shore-line of this island has never been protected. The east and south bluffs, however, should be covered by sea-walls to prevent any additional abrasion, not only to secure the sites of the important heavy batteries occupying these bluffs, but also to prevent injury to the Main Ship-channel. The east bluff wall should be 500 feet long, and is estimated to cost $30,000; the south bluff wall should be 1,800 feet long, and will cost $50,000.

WORKS OF IMPROVEMENT.

The Main Ship-channel.—Before improvement it had a least width of 100 feet, and a least depth of 18 feet at mean low water. The general project for its improvement was submitted in 1867; it proposed to dredge the channel 23 feet deep at mean low water, 1,000 feet wide at the "Upper" and "Lower Middles" and 685 feet wide at the "Narrows." In 1870 the proposed width at the "Narrows" was reduced to 625 feet, and increased to 1,100 at Anchorage Shoal in the inner harbor. In 1887 it was proposed to straighten the passage through the "Narrows" by cutting off a spur that projected from Lovell's Island, and was estimated to contain 20,000 cubic yards.

During the fiscal year ending June 30, 1888, operations have been in progress under a contract with Mr. J. E. Chapman, dated March 19, 1887, to dredge from the "Lower," "Middle," and "Narrows" 44,000 cubic yards. This contract on January 2, 1888, was extended and enlarged to cover the removal of a total of 94,000 yards. Operations under this contract were commenced October 25, 1887, and during the year 65,576 yards were dredged from the "Lower Middle" and 3,430 yards from the "Narrows," or a total of 69,006 cubic yards dredged under the contract. The contract was closed before completion by mutual consent, June 6, 1888, which was approved by the Secretary of War, June 13, 1888, in order that funds might be available to immediately remove three small ledges which had been developed by the dredging at the "Lower Middle." The existence of these ledges by their position in the channel almost completely nullified the advantages which had been gained by the dredging. The ledges contain 300 cubic yards, approximately, above the plane of 23½ feet below mean low water, and the least depth on them is 17 feet.

On June 22, 1888, a contract was entered into with Mr. G. W. Townsend, of Boston, Mass., for the removal of these ledges, at $22 per cubic yard. This contract was approved by the Chief of Engineers June 26, 1888, and operations under it will be commenced by the contractor early in July, 1888.

On June 30, 1888, the condition of the Main Ship-channel was as follows: It was 23 feet deep at mean low water, 1,100 feet wide west of the "Upper Middle," 600 feet wide at the "Upper Middle," 1,000 feet wide at the "Lower Middle," 625 feet wide at the "Narrows."

From the "Narrows" to the entrance of the harbor no detailed survey of the channel has been made, but it is known that it is obstructed by ledges and shoals, especially off Nash's Rock, where the available

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width (full 23 feet deep) is less than 500 feet. In effecting this improvement, dredging and blasting were done at the following places:

At Nash's Rock Shoal during the years 1876–1878, 365 cubic yards of ledge were removed.

At Kelly's Rock and Shoal during the years 1869–1879, 222 cubic yards of ledge were removed.

Tower Corwin and Channel Rocks were removed during the years 1867–1875. They aggregated 608¾ cubic yards.

From the west end of the Brewster Spit, during the years 1874–1876 29,226 cubic yards of sand and gravel were dredged and 95½ cubic yards of ledge were removed.

At Lovell's Island, from the southeast and southwest points, 267,294½ cubic yards were dredged during the years 1867–1877; and from a spur between these points 3,430 cubic yards were dredged in 1888.

At Castle Island Bar and Shoal, opposite the Lower Middle, during the years 1880–1883, 36,957 cubic yards were dredged and 20 tons of rock were removed.

At the Lower Middle, in 1874–1875, State and Palmyra rocks were removed. They aggregated 62 cubic yards. In 1887–1888, 65,576 cubic yards were dredged from this shoal.

At the Upper Middle, during the years 1870–1876, 268,278½ cubic yards were dredged and 118½ cubic yards of ledge were removed.

At Anchorage Shoal, during the years 1879–1882, 65,327 cubic yards were dredged.

At Man-of-War Shoal, 85,917 cubic yards were dredged in the years 1878–1880.

At Mystic River Shoal, during the years 1879–1882, 82,082 cubic yards were dredged. To complete the present project for the improvement of the Main Ship-channel, 687,500 cubic yards must be dredged from the Upper Middle, in the inner harbor, at an estimated cost of $250,000, and 17,000 cubic yards from the Narrows, in the lower harbor, at an estimated cost of $5,000. A detailed survey of the lower harbor from Long Island to the sea should be made, the bottom carefully examined to reveal all obstructive ledges, and current observations taken. This survey will demand three or four months field work, and will cost, it is estimated, not less than $6,000.

The improvements by dredging both in the inner and outer harbor have been remarkably well maintained and show no essential deterioration, with the exception of the dredging done at the western end of Great Brewster Spit, or the eastern entrance of the "Narrows." Here, as shown by the latest surveys, the condition of the entrance is almost exactly what it was previous to the dredging. To propose a project for the further improvement of this outer part of the Main Ship-channel will require continued study, and the collection by surveys of additional information. It may involve a radical change in the location of the channel to the south and west of George's Island, or at least indicate how a new channel may be opened to the westward at comparatively small expense for the relief of the existing over-crowded channel through the Narrows.

In addition to these improvement of the Main Ship-channel through the inner and outer harbor, dredging and blasting have been done in the following tributary channels:

I.—CHARLES RIVER.

This river enters the inner harbor near the navy-yard at Charlestown. Before improvement the natural channel had, as far up as Western

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Avenue Bridge, 4¾ miles from its mouth, 7 feet depth at mean low water, except in several places covering about 1¼ miles in extent below Brookline Street Bridge, where the depth varied from 4½ to 7 feet. From Western Avenue Bridge up to Arsenal Street Bridge (2½ miles), there was a depth of 4 feet, mean low water; thence to Market Street Bridge (¾ mile) 2½ feet at mean low water, and thence to the dam at the head of tide-water (1¾ miles), a depth varying from 0 to 9½ feet *above* mean low water. The mean rise or fall of the tide is 10 feet. A sketch showing the river was published in the Chief of Engineer's Report for 1884, page 512.

The project for the improvement of this river consists in straightening, widening, and deepening the natural channel, so that it should be, from its mouth to Western Avenue Bridge, 7 feet deep at mean low water and 200 feet wide; from Western Avenue Bridge to Market Street Bridge, 6 feet deep at mean low water and 80 feet wide, and thence to the dam at head of tide-water 60 feet wide and 2 feet deep at mean low water.

The estimated cost of this improvement was originally $85,000. But a revised estimate was submitted in 1881 of $125,000.

The total appropriations for this improvement to date have been $57,500. The total expenditures to June 30, 1888, were $57,378.99.

No operations were in progress during the fiscal year, and the condition of the improvement June 30, 1888, is as follows: The projected channel had been completed from the mouth of the river to Arsenal Street Bridge (7¼ miles); work was stopped at this point for the reason that the draws and piers of this bridge do not conform to the projected channel above it. In effecting this improvement 127,971 cubic yards were dredged during the years 1880–1884.

This improvement, even if the project were completed, is not regarded as an important benefit to commerce, for the conditions which exist on the lower reach of the river between Boston, Cambridge, and Charlestown make navigation of most any kind extremely expensive, slow, and difficult. Seven railroad and municipal bridges now exist on this lower part of the river, and an eighth is being built on the extension of West Chester Park street, under authority of a State act. No recommendation is made for the continuation of the improvement. The funds available July 1, 1888, will be expended in surveys and examinations of the work.

II.—FORT POINT CHANNEL.

This channel is situated between the eastern shore of Boston proper on the one side, and the reclaimed and improved flats of South Boston and South Boston on the other side. It connects the tidal basin of South Bay, which has an area of 250 acres, with Boston inner harbor; is fast becoming the center of the city's most extensive shipping trade and is the most important branch of the Main Ship-channel. Fort Point Channel is 1¼ miles long. Before improvement the least depth at mean low water was 12 feet at its entrance and 17 feet above Congress Street Bridge. That part of it which it is proposed to improve is spanned by bridges at Congress street, Mt. Washington avenue, and at an intermediate point. These bridges have conveniently located draw openings, but the draw-piers of the railroad bridge must be strengthened or reconstructed before the improvement can be extended past them, and the width of the draw increased to that of the other bridges above and below it. The project for this improvement was submitted January 27, 1885, Annual Report Chief of Engineers, 1885, page 545. It proposed

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the excavation of a channel 175 wide and 23 feet deep at mean low water from the entrance to near Federal Street Bridge, a distance of 4,100 feet and was estimated to cost $100,000; the railroad bridge to be constructed at the expense of the owners.

By the river and harbor act of August 5, 1886, the sum of $18,750 was appropriated for the improvement of that part of the channel lying below Congress Street Bridge.

The total expenditures to June 30, 1888, were $17,439.50.

No appropriation was made for the fiscal year ending June 30, 1888. No operations were in progress during the fiscal year, and the condition of the improvement on June 30, 1888, was as follows: The channel had been dredged as proposed from its entrance to Congress Street Bridge, a distance of 1,900 feet; 94,211 cubic yards were removed effecting this improvement during the year 1887.

The funds available July 1, 1888, will be expended in examinations of the work. To complete the improvement as proposed to Federal Street Bridge will cost $60,000, and an appropriation for this purpose is recommended applicable only after the railroad-bridge draw shall have been properly reconstructed.

III.—HINGHAM HARBOR.

See separate report.

IV.—NANTASKET BEACH CHANNEL.

This is a small channel along the east side of Hingham or Hull basin. It leads to a wharf on the west side of the heel of Nantasket Beach, about 12 miles from Boston.

Before improvement it was approximately 100 feet wide and had a depth of at least 11 feet, except at the eastern end, 1,500 feet from the wharf, where the width was reduced to 40 to 50 feet, and the depth to less than 8 feet. It was circuitous, and obstructed by bowlders at the mouth of Weir River, and by a ledge near the wharf. The project adopted in 1880 was to widen and deepen the channel from the mouth of Weir River to the steam-boat wharf, so that it would be 100 feet wide and 9½ feet deep, mean low water; to remove a few bowlders at the mouth of Weir River, and to remove the ledge near the wharf.

The total appropriations and allotments for this work to date have been $11,750.

The total expenditures to June 30, 1888, were $11,750.

No operations were in progress during the fiscal year, and the condition of the improvement June 30, 1888, was as follows: The projected channel had been completed by the removal of 41,922 cubic yards of material dredged, and 54 cubic yards of ledge blasted, during the years 1881–1883. The improvement meets the present demands of commerce, and no further appropriation is required at this time.

V.—CHANNEL BETWEEN NIX'S MATE AND LONG ISLAND.

This is a channel through the bar which extends from the north head of Long Island to Nix's Mate Shoal. Previous to the improvement there was 4½ feet depth of water on the bar at mean low tide. The project for the improvement was adopted in 1883. It was to dredge a channel 200 feet wide, 12 feet deep at mean low water, and about 550 feet long. In 1887 it was recommended that the axis of the cut be

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shifted 30° to the westward, and that it be widened to 300 feet, 15 feet deep at mean low water.

The original project was estimated to cost $9,000. The project of 1887 was estimated to cost $25,000.

No specific appropriation has been made for this work.

The expenditures on it to June 30, 1888, from the appropriation for the improvement of Boston Harbor, have been for dredging $9,551.76.

No operations were in progress during the fiscal year, and the condition of the improvement June 30, 1888, was as follows:

The original project had been completed by the removal of 19,899½ cubic yards of material during the fiscal year 1884.

The latest survey shows that this channel has retained its full width and deepened throughout 1 foot approximately.

The channel has been of the greatest service to the vessels and boats which ply to the wharves of the lower harbor, and has conferred a great benefit upon commerce by diminishing the number of passages of medium craft through the "Narrows," where the channel is narrow and overburdened and the currents transverse and irregular. These advantages will be largely increased so soon as the modified project of 1887 shall have been completed, and an appropriation or allotment is recommended for this purpose.

VI.—BROAD SOUND.

An obstruction called Barrel Rock, lying on the north side of the Broad Sound Channel, was removed in 1869. It contained 116 cubic yards.

The balance available July 1, 1888, $8,297.75, will be expended in removing the group of three ledges which obstruct the main ship-channel at the eastern end of the Lower Middle Bar. No appropriation was made for this harbor for the fiscal year ending June 30, 1888. The river and harbor bill for the fiscal year ending June 30, 1889, contains at item for Boston Harbor of $125,000. Should this sum be appropriated by the Fiftieth Congress, first session, it will be mainly applied towards widening the channel at the Upper Middle Bar, and towards extending and repairing sea-walls, and by so much will reduce the amount, $449,000, estimated in this report as required for the fiscal year ending June 30, 1889.

RECAPITULATION OF APPROPRIATIONS RECOMMENDED.

The amount recommended for expenditure for improvements in Boston Harbor, Mass., during the fiscal year ending June 30, 1889 are as follows:

Extension of sea-water at George's Island	$10,000
Extension of sea-wall at Gallop's Island	15,000
Extension, etc., of sea-wall at Long Island	3,000
Sea-walls at South and East Bluffs of Governor's Island	80,000
Widening Main Ship-Channel at the "Upper Middle"	250,000
Completing Fort Point Channel	60,000
Widening and deepening Nix's Mate Channel	25,000
Survey of Main Ship-Channel east of Long Island Head	6,000
Total	**$449,000**

The several works completed and projected for improvement of this harbor are located in the collection district of Boston and Charlestown, Mass. Boston is the port of entry.

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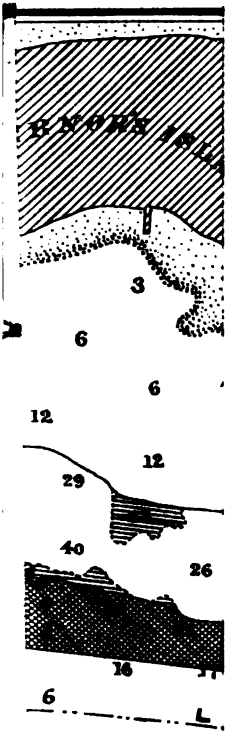

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The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs at Boston, Mass.

Money statement.

July 1, 1887, amount available		$34,712.42
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$23,396.04	
July 1, 1888, outstanding liabilities	1,587.12	
July 1, 1888, amount covered by existing contracts	6,600.00	
		31,583.16
July 1, 1888, balance available		3,129.26
Amount appropriated by act of August 11, 1888		125,000.00
Amount available for fiscal year ending June 30, 1889		128,129.26
Amount (estimated) required for completion of existing project		325,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		325,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for the removal of rock from the main ship channel, Boston Harbor, Massachusetts, opened May 12, 1888, by Lieut. Col. G. L. Gillespie, Corps of Engineers.

No.	Names of bidders.	Price bid per cubic yard, measured in situ.	Remarks.
1	George W. Townsend	$22 00	Lowest bid.
2	Thomas A. Rowe	23.75	
3	W. D. Duncan & Nickerson. N. E. Gordon	38.00	
4	Hiram W. Phillips	50.00	
5	Thomas Symonds	25.50	

The contract was awarded to Mr. George W. Townsend, with the approval of the Chief of Engineers.

Transaction of commerce and navigation at the port of Boston during the fiscal year ending June 30, 1888.

Importations:	
Merchandise	$63,897,778
Coin and bullion	$47,375
Domestic exportations:	
Merchandise	$55,515,863
Coin and bullion	none.
Foreign exportations (returned exports):	
Merchandise	$974,720
Coin and bullion	none.
Vessels entered from foreign ports:	
Number	2,467
Tonnage	1,321,167
Vessels cleared for foreign ports:	
Number	2,379
Tonnage	1,099,899
Total customs collections from all sources	$21,396,776.15

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B 8.

IMPROVEMENT OF MALDEN RIVER, MASSACHUSETTS.

Malden River is tributary to Mystic River, into which it empties, 3 miles from the mouth, at the navy-yard in Boston Harbor, Massachusetts.

Previous to its improvement there was a navigable depth of barely 7 feet at mean high water, and the mean rise or fall of the tide is 9.8 feet.

The object of the improvement is to increase the width and depth of the river channel from its mouth to the second bridge in Malden, a distance of 2 miles.

The project was originally proposed in 1880. It was to excavate a channel 100 feet wide and 12 feet deep at mean high water, up to the second bridge in Malden, with two cut-offs, one east of the island near the mouth of the river and one through the marsh, about one-half mile above.

The project was modified in 1882, when it was proposed to make the natural channel of the river 100 feet wide, 12 feet deep at mean high water, to the first bridge in Malden, thence to the second bridge, 75 feet wide, with the same depth. The cost of the original project was estimated to be $40,000.

The total appropriations for the work to date are $10,000.

The total expenditures to June 30, 1888, were $10,000.

The condition of the improvement June 30, 1888, was as follows:

The channel had a least width of 50 feet (it was 70 feet wide at turns) and had a depth of 12 feet at mean high water from its mouth to the first bridge in Malden, a distance of 1¼ miles.

No work was done during the fiscal year ending June 30, 1888.

The improved channel is in good order and meets all the existing demands of commerce.

No appropriation is recommended for the year ending June 30, 1890.

There is no balance available July 1, 1888.

Malden River is in the collection district of Boston, Mass. The nearest port of entry is Boston, Mass. The nearest light-house is Long Island head-light in Boston Harbor, Massachusetts, about 7 miles distant.

(Commercial statistics included in Boston Harbor, Massachusetts.)

B 9.

IMPROVEMENT OF HINGHAM HARBOR, MASSACHUSETTS.

Hingham Harbor is situated in the southern part of Hingham or Hull Basin, which comprises all that part of Boston Lower Harbor south of Nantasket Roads. It is distant about 12 miles from Boston in a southeasterly direction.

The harbor covers an area of 1 square mile, with extensive mud flats bare at low tide. The mean rise or fall of the tide is 9.4 feet.

The channel leading to Hingham south of Ragged and Sailor's islands was, before improvement, very narrow and crooked and obstructed by sunken rocks and shoals. Its least width was 30 feet, and least depth 4 feet at mean low water.

The object of its improvement is to widen and deepen the natural channel from deep water near the head of the harbor to the steam-boat wharf, a distance of about 2,500 feet.

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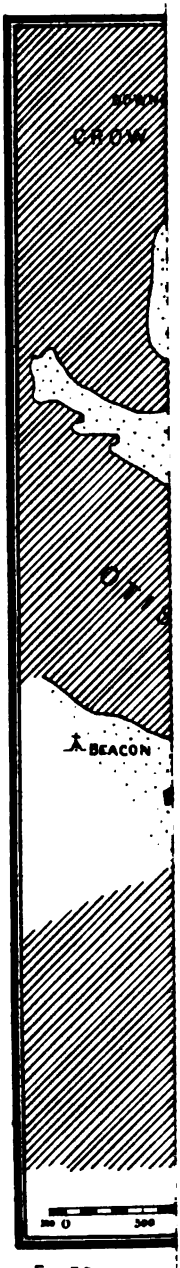

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The original project for improvement was submitted December 23, 1874. It provided for an improved channel on the east side of Sailor's Island, past the west side of Beacon to the Hingham wharf, 100 feet wide and 8 feet deep at mean low water, at an estimated cost of $11,000. This project was modified January 20, 1885, when it was proposed to deepen the improved channel to 10 feet at mean low water, and to remove a mid-channel ledge lying between Chandler's and Ragged islands, measuring 128 cubic yards, at a total cost of $18,700.

A plan of the harbor is submitted herewith. The channels A D and B D are described in Annual Report for 1875.

The total amount appropriated to date for this harbor is $16,000.

The total expenditures to June 30, 1888, were $16,000.

By this expenditure up to June 30, 1888, the original project had been completed, and the modified project of 1885 had been partly completed by dredging and blasting the channel 10 feet deep and 50 feet wide through the ledge, which extends for 280 feet in length in the improved channel, about 1,600 feet northeast of the steam-boat wharf.

During the fiscal year ending June 30, 1888, no active operations were in progress from want of funds. The balance of $76.74, available July 1, 1887, was expended for office expenses.

To complete the present project will require an appropriation of $13,000.

The following is a tabular statement of the items included in the estimate for $13,000.

Removal of 128 cubic yards from ledge between Ragged and Chandler's islands, at $25	$3,200
Removal of 200 cubic yards from ledge opposite Samuel Burr's, at $25	5,000
Dredging 20,000 cubic yards of material from the bend near Samuel Burr's to the steam-boat wharf at Hingham, to give a channel 100 feet wide and 10 feet deep at mean low water, at 20 cents	4,000
Contingencies	800
Total	13,000

No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill for the fiscal year ending June 30, 1889, contains an item of $5,000 for continuing this improvement, and if appropriated this sum will be applied in widening and deepening the channel near Samuel Burr's.

This work done, there will be still required the sum of $8,000 to complete the project. A recommendation for an appropriation of $8,000 is made for the fiscal year ending June 30, 1890.

The benefit to be expected from the completion of this improvement is a more convenient and safe navigation of the improved channel.

Hingham Harbor is in the collection district of Boston, Mass. The nearest lighthouse is the Narrows light on the Main Ship-channel in Boston Harbor, distant about 5 miles.

(Commercial statistics included in Boston Harbor.)

Money statement.

July 1, 1887, amount available	$76.74
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	76.74
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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B. 10.

IMPROVEMENT OF SCITUATE HARBOR, MASSACHUSETTS.

Scituate Harbor is on the west shore of Massachusetts Bay, 14 miles from either Boston or Plymouth light-houses, and just southwest of the direct sailing course of all ocean-going vessels entering Boston Harbor.

Before improvement the harbor had a low-water area of 57 acres approximately, more than 6 acres of which had a depth of at least 3 feet at mean low water. It was entirely open to the action of easterly winds, and the entrance was obstructed by many detached bowlders. The depth on the bar was about $2\frac{1}{2}$ feet at mean low water, and the mean rise or fall of the tide is $8\frac{9}{10}$ feet.

A plan of the harbor, showing the proposed improvement, was published in the Annual Report of the Chief of Engineers for 1881, Part I, page 522.

The object of the improvement is to create a harbor of refuge for vessels bound to Boston that are too far south of their true course to clear the dangerous ledges near Minot's light-house.

The project for the improvement adopted in 1881 is to build two rubble-stone jetties converging towards each other from opposite banks, and to dredge an anchorage basin with channels connecting with the sea and the town wharves. The north jetty from Cedar Point to be 800 feet long, and the south jetty from the point of the "First Cliff" to be 730 feet long.

Both jetties are to be 20 feet wide on top, and 4 feet above mean high water, except at their outer ends, which are to be built 6 feet higher to serve as sites for entrance beacons.

The anchorage basin to be 30 acres in area, approximately. The entrance channel to be 2,700 feet in length, and 300 feet average width. The estimated amount of dredging (including the entrance channel) was 500,000 cubic yards, to give a depth of 15 feet at mean low water in the entrance channel; 12 to 15 feet between the jetties; 12 feet immediately in rear of the south jetty, and 10 feet for the anchorage basin. The estimated cost of the jetties was $100,000, and of the dredging $190,000, a total of $290,000. The total amount appropriated for this work to date is $47,500.

The amount expended to June 30, 1888, was $47,500.

By this expenditure the north jetty had been essentially completed; it was 720 feet long, of full width and height. The entrance channel was made 100 feet wide, 1,600 feet long, and 5 feet deep at mean low water. The anchorage basin was made 400 by 350 feet in area, 7 feet deep. Nothing had been done on the south jetty.

A portion of the beach between Cedar Point and the mainland had been protected by a brush and stone bulkhead 450 feet long, in front of which was a stone apron 10 feet wide and 385 feet long, and all known bowlders obstructing the entrance had been removed.

No operations were in progress during the year ending June 30, 1888, from want of funds.

No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill for the fiscal year ending June 30, 1889, contains an item of $5,000 for continuing this improvement. If this amount should be appropriated at the present session of Congress, it might be judiciously applied toward opening a channel 25 feet wide and 3 feet deep, to connect the basin with the town wharf. On the completion of this work the amount required to complete the project will be $237,500.

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Of this amount $50,000 could be profitably expended during the fiscal year ending June 30, 1890, and, if appropriated could be judiciously expended as follows:

Build south jetty 400 feet long, 10,000 tons rubble-stone at $2.15	$21,500
Enlarge anchorage basin to four acres, 10 feet deep, and the channel to the town wharf to 150 feet wide, with same depth; 70,000 cubic yards dredging at 33 cents	23,100
Contingencies	5,400
Total	50,000

Scituate is in the collection district of Plymouth, Mass. The nearest port of entry is Plymouth, Mass. The nearest light-house is Minot's light, about 5 miles distant.

The accompanying commercial statistics have been furnished by the collector of customs at Plymouth, Mass.

Money statement.

July 1, 1887, amount available	$474.72
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	474.72
Amount appropriated by act of August 11, 1888	5,000.00
Amount (estimated) required for completion of existing project	237,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Foreign arrivals (74 tons)	1	
Domestic arrivals	12	
		13
Foreign clearances	1	
Domestic clearances	12	
		13
Four cargoes of coal	tons..	680
Eight cargoes of lumber	feet..	550,000

In addition to the above a number of small boats are principally engaged in gathering moss.

B 11.

IMPROVEMENT OF PLYMOUTH HARBOR, MASSACHUSETTS.

Plymouth Harbor is situated 30 miles south of Boston. Its outer anchorage, the "Cow-Yard," is common to Plymouth, Kingston, and Duxbury, and is the only refuge for sea-going vessels from northeasterly gales when caught between Boston and Provincetown, a distance of about 75 miles, following the coast-line. The entrance to this outer anchorage is direct, unobstructed, of ample width, and sufficiently deep for the wants of commerce. The anchorage is capacious, and has good "holding ground," but the extensive tidal basins inside of it give rise to strong variable currents across it.

The inner or harbor proper is formed by Long Beach, a narrow low sand-spit 3 miles long, which runs generally parallel to the mainland and about a mile from it.

The harbor contains 2,000 acres, almost all of which is dry at low tide. A few narrow, crooked, shallow channels traverse these flats. These

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channels join about the center of the harbor, opposite the town wharves, and form the main ship-channel, 150 feet wide approximately and 10 feet deep at mean low water, which runs directly behind the northern half of Long Beach to the outer anchorage.

The maintenance of this inner harbor and channel depends on the preservation of Long Beach.

Before improvement about 6 inches depth only of water could be carried to the town wharves at low tide.

Previous to 1875 the project was a general one, and had for its object the *preservation* only of Long Beach. From the nature of the work it can at no time be considered completed, and small annual appropriations are necessary to repair any damage done by storms. The various devices employed for this purpose are described in the Annual Report of the Chief of Engineers for 1877, all of which have been remarkably successful.

The project for the *improvement* of the harbor was first adopted in 1875. It provided for dredging a channel from the town wharves to the main ship-channel, 2,286 feet long, 100 feet wide, and 6 feet deep at mean low water. This project was modified in 1877 so as to include the dredging of a basin 866 feet long, 150 feet wide, and 8 feet deep, directly in front of the town wharves.

In 1884 and 1885 it was proposed to deepen the improved channel and basin to 9 feet at mean low water, and to make their approaches more easy.

The modified project of 1884 required the excavation of 81,000 cubic yards (scow measurement), and was originally estimated to cost $27,000.

This estimate was revised in 1885, in accordance with the low prices then current for dredging, and the cost was then estimated to be $22,500. From 1866 to date the amount appropriated for this improvement was $114,800, of which there had been expended to June 30, 1888:

For beach protection	$72,587.56
For dredging, etc	42,212.44

During the fiscal year ending June 30, 1888, 8,312 cubic yards of material were removed from the improved channel and basin under a contract with the New England Dredging Company, dated October 22, 1886. This contract was satisfactorily completed in July, 1887, and a total of 23,124 cubic yards were dredged at a contract price of 24 cents per yard. A small bowlder developed by the dredging was removed by hired labor in August, 1887.

During the latter part of the fiscal year a survey of the dredged basin and channel was made, and lines of soundings were also run over the main ship-channel to its junction with the outer anchorage. This survey shows that the basin and improved channel have not deteriorated since dredging was suspended in July, 1887, though it is noticed that extensive changes have taken place in the shoals surrounding the main ship-channel, especially between Plymouth Beacon and Duxbury Pier Light, since the survey of 1870. The channel is, however, essentially uninjured, and at least 9 feet depth at low water can be carried to the town wharves. A chart showing the results of the survey accompanies this report.

The condition of the improvement on June 30, 1888, is as follows: The improved channel was 115 feet in width, 9 feet in depth for 90 feet of its width nearest the town wharves, and the remainder averaged 5 feet depth. Long Beach was in good order throughout and the works of preservation on it required no repairs or extensions.

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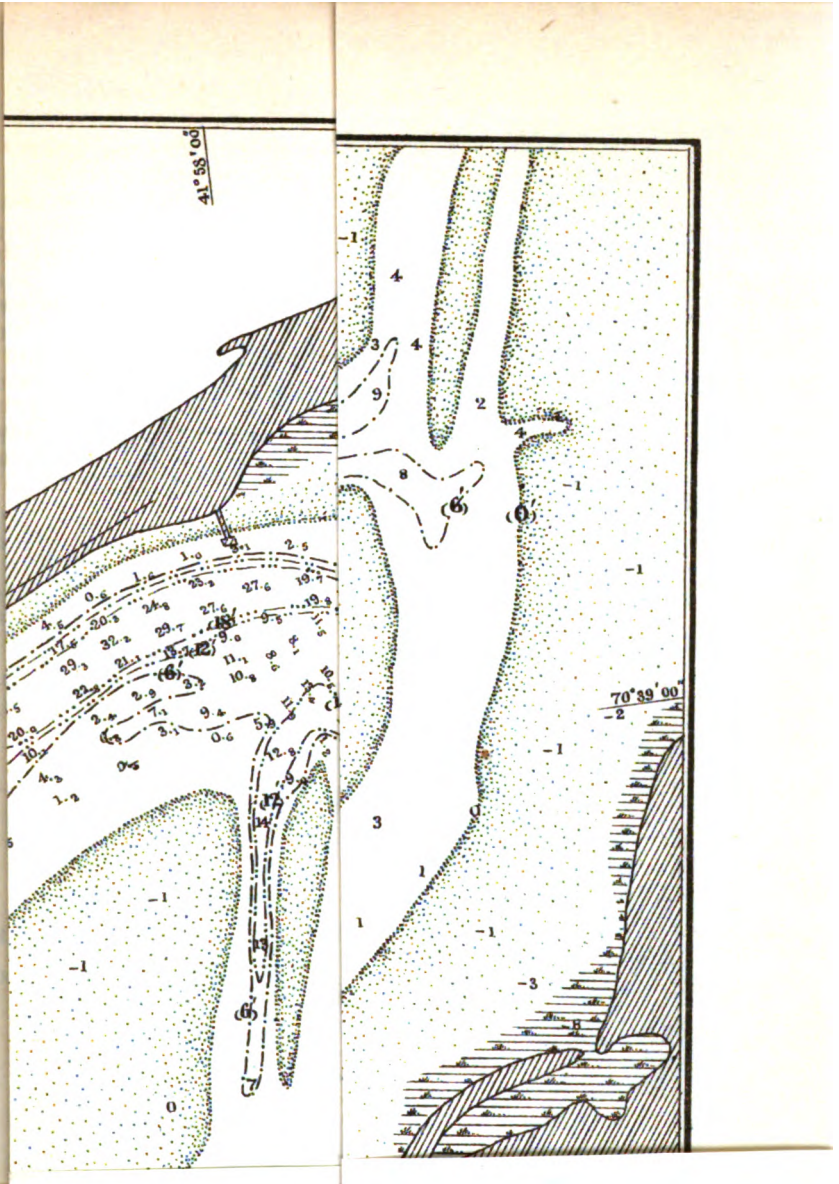

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No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill (not yet passed) for the fiscal year ending June 30, 1889, contains an item of $5,000 for continuing the improvement, and if this sum should be appropriated it will be applied towards completing the project by widening and deepening the basin. This work done, there will still be required the sum of $9,500 to complete the project. An appropriation of $9,500 is recommended for continuing the improvement for the fiscal year ending June 30, 1890.

The prospective benefits to commerce are increased facilities and safety in navigating the improved channel.

Plymouth Harbor is located in the collection district of Plymouth, Mass., of which Plymouth is the port of entry. The nearest light-houses are the Plymouth (Gurnet) lights, about 5 miles from Plymouth, and Duxbury Pier Light, about 2 miles distant.

The accompanying commercial statistics for the fiscal year ending June 30, 1888, have been furnished by the collector of customs at Plymouth, Mass.

Money statement.

July 1, 1887, amount available	$2,957.39
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,957.39
Amount appropriated by act of August 11, 1888	6,000.00
Amount (estimated) required for completion of existing project	9,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	9,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Revenue collected during the fiscal year ending June 30, 1888	$91,919.97
Derived from the following sources, namely:	
Duties on imports from hemp	42,205.42
Duties on imports from sisal-grass	13,504.50
Duties on imports from rivet-wire rods	18,711.86
Duties on imports from wool	10,710.80
Duties on imports from bar iron	7,745.84
Duties on imports from steel bars	3,944.70
Duties on imports from salt and lumber	96.85
Total	91,919.97

Shipping.	No. of vessels.	Tonnage.
Foreign entrances	3	1,327
Foreign clearances	5	1,648

Coastwise entrances were 114 in number, namely:

78 cargoes of coal	tons	27,300
25 cargoes of lumber	feet	2,700,000
3 cargoes of granite	tons	300
3 cargoes of cement and lime	do	600
2 cargoes of brick	do	240
2 cargoes of hay	do	120
1 cargo of tar	bbls	1,775

The above items do not include ordinary packet running, and in addition thereto a steamer runs regularly during the summer months.

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B 12.

IMPROVEMENT OF PROVINCETOWN HARBOR, MASSACHUSETTS.

Provincetown Harbor is situated at the extremity of Cape Cod, about 40 miles southeast from Boston Light. It is one of the most valuable harbors of refuge on the Atlantic coast. The entire commerce of New England and a very large local fishing interest are directly benefited by its maintenance, which depends entirely on the preservation of the sandy beaches which inclose it.

Since 1826 the project has been a general one, and provides for the *preservation* of the harbor by building dikes, bulkheads, and sand-catches, and extensive planting of beach grass, to repair or prevent storm damages to the beaches. From the nature of the work it can at no time be considered completed. A full history of these improvements will be found in the Annual Reports of the Chief of Engineers for the years 1876, 1879, and 1886. A special dike across House Point Island Flats, to be built contingently, was recommended in the Annual Report for 1886.

A plan of the harbor was published in the Annual Report of the Chief of Engineers for 1886.

The total appropriations or allotments for this work up to date have been $139,478.44.

The amount expended up to June 30, 1888, was $139,328.09.

The condition of the improvement June 30, 1888, was as follows:

Long Point.—This long, narrow, low point forms the southeastern limit of the harbor. It had been protected on the east or outside by bulkheads, groins, and aprons built of rubble-stone. These were all generally in good order, except that 600 tons of additional large stone were required to level up the bulkhead near the northern end; and it required to be repaired and backed with brush and small stone to prevent the sea making through it to the injury of the beach behind it. For this purpose an appropriation is recommended. At the narrowest part of the point, 3,000 feet west of Wood End Light, a gap in the beach had been worn by the portage of fishermen's boats, etc.

This was closed during the fiscal year by wood and brush sand-catches with five jetties, aggregating 232 feet in length, and 5 acres of beach grass were planted on the inside opposite this gap.

Abel Hill Dike.—This dike was built to prevent the rush of water from Lancy's Harbor over House Point Island Flats into the main harbor.

The rapid wearing away of the southern sand-spit that forms Lancy's Harbor had threatened to make a breach through the beach south of the dike. To guard against this, brush and wooden sand-catches had been built on the outer beach opposite the west end of the dike. These sand-catches were repaired and extended during the fiscal year by building an additional length of 257½ feet.

House Point Island Flats.—These flats remained essentially unaltered from the condition shown by the last survey and stated in last annual report. It still appears unnecessary to commence the dike projected to be built across these flats.

Beach Point, High Head Dike, and Cove Section.—These works were all in good order, and have required no extensions or repairs during the year.

At the date of this report the several works of preservation are in good order, and serve the purpose for which they were built.

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No appropriation was made for the fiscal year ending June 30, 1888. The river and harbor bill now pending, for the fiscal year ending June 30, 1889, contains an item of $7,000 for improving Provincetown Harbor, and if this sum should be appropriated, it will be applied in leveling up and backing the Long Point Breakwater, and in repairing probable storm damages to other points of the covering beaches. This work completed, an appropriation of $2,500 is recommended for the fiscal year ending June 30, 1890, for application towards the repair of probable storm damages to the beaches.

The prospective benefit to commerce is the preservation of an important harbor of refuge.

Provincetown is a port of entry in the collection district of Barnstable, Mass. The nearest light-houses are Wood End and Long Point lights.

The accompanying commercial statistics have been furnished by the deputy collector at the port of Provincetown, Mass.

Money statement.

July 1, 1887, amount available	$2,144.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,993.69
July 1, 1888, balance available	150.35
Amount appropriated by act of August 11, 1888	7,000.00
Amount available for fiscal year ending June 30, 1889	7,150.35
Amount (estimated) required for completion of existing project	2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commercial statistics for the fiscal year ending June 30, 1888.

Shipping.	No. of vessels.	Tonnage.
Foreign arrivals	28	3,425
Foreign clearances	32	4,244

Amount collected for imports	$210.68
Amount collected for tonnage tax	94.64
Amount collected for immigrant fund	80.50

The total number of vessels which have entered the harbor at Provincetown, Mass., for shelter and other purposes during the fiscal year ending June 30, 1888, is five thousand; estimated value, at the rate of $10,000 each, $50,000,000.

B 13.

PRELIMINARY EXAMINATION OF MANCHESTER HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 20, 1886.

GENERAL: In compliance with instructions contained in your letter of September 27, 1886, I have the honor to submit the report of a preliminary examination of Manchester Harbor, Massachusetts, provided

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for in the river and harbor act approved August 5, 1886. Manchester Harbor is situated on the eastern shore of Massachusetts, upon Massachusetts Bay, 5½ miles northeastward of the entrance to Salem Harbor. At the entrance there is a small sheltered roadstead, containing 300 acres or more, with 5 fathoms water, formed by Great Misery Island, House Island, and the mainland terminating in Gale's Point, which is much used by fishing-vessels during northeasterly, easterly, and southerly storms. The entrance is marked by a light-house on Baker's Island, and the channels east and west of Great Misery Island are buoyed by the Light-House Department. The roadstead shoals gradually towards the entrance to Manchester Harbor, and opposite Glass Head; at the immediate entrance the depth is 3 feet mean low water. At a distance of 2,500 feet farther inland, at the Narrows, the width of the water-way is contracted to less than 1,000 feet, and the depth reduced to 1 foot, approximately, mean low water. Thence to the wharves at the upper end of the bay, where the town of Manchester is located, is practically no water at low stage. The bed of the harbor is composed of loam and sand, with a few bowlders visible close inshore. At a conference which I had with the selectmen of the town on November 10, 1886, I was informed that the Government expended about $5,000 thirty years ago in blasting and removing rocks alongside the channel at the Narrows. The printed records contain no statement of such appropriation or improvement. I have not been able to learn that it was an improvement by the State or by private individuals.

The harbor is divided into the upper and lower harbor by the contraction at the Narrows, and the distance from the 3-foot curve at the entrance to the town wharves is 1 mile. No hydrographic survey of the harbor has ever been made, but the citizens claim that there was formerly a depth of 3 feet mean low water into the upper harbor, and that the decline in shipping and the present disuse of the harbor are due to the decline in the navigable depths, which are now such as to practically close the harbor at low tide.

The improvement desired is the restoration of the channel to its former depth of 3 to 4 feet mean low water. This will require the dredging of a channel 5,000 feet long, 60 feet wide, and 2½ to 3 feet deep, with an estimated excavation of 100,000 cubic yards of material.

The inclosed paper prepared by the selectmen of Manchester gives an exhibit of the interest represented in the harbor and the country adjacent. The sheltered roadstead at the entrance, the facility with which it may be entered from the main ship-channel leading to Salem Harbor, and the additional shelter which may be gained by excavating a channel into Manchester Harbor, make this an important harbor of the third class.

The citizens are fully justified in asking relief from the Government. It will be practicable at small cost to open a narrow channel to the lower wharves for the use of vessels in transporting at reduced rates to the town and adjacent country those supplies now carried by rail, which most generally enter into home consumption, such as coal, lumber, products of iron and mercantile articles.

The harbor is worthy of improvement, and I respectfully recommend an allotment of $1,000 for making a complete hydrographic survey of the harbor from the 6-foot curve of the roadstead to the lower wharves.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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COMMUNICATION FROM THE SELECTMEN, MERCHANTS, ETC., OF MANCHESTER, MASSACHUSETTS.

MANCHESTER, *November* 17, 1886.

DEAR SIR: We, the undersigned selectmen, merchants, and residents of the town of Manchester, Essex County, Mass., respectfully submit that the improvement of our harbor is necessary and expedient for the following reasons, among others, viz:

(1) That our commercial and manufacturing interests have been injured by the gradual filling up of our harbor. There was formerly a good channel, which has been obstructed by the accumulations of years. Within twenty-five years vessels loaded with coal and drawing 11 feet of water could enter the harbor and unload. At the present time it is necessary to bring the coal to Salem by vessel and from there it must be brought down by rail 9 miles and carted to mills, thus making an extra cost for transportation, to be borne by the consumers.

The consumption of coal has increased within the past twelve years from 800 to 2,800 tons, and a continued increase is anticipated. While this coal could formerly be unloaded at the dock, it is necessary now to bring it in by lighters when it comes by sea, or else by rail as above stated.

In former years vessels ran between Manchester and Boston, carrying our manufactures of furniture, etc., and bringing articles of home consumption in return. Now it is necessary to send everything of this kind by rail.

Formerly a large part of the hay produced here was sent away to be sold. The product of hay is now greater than ever before, but it is all consumed here, and fully as much more brought in from Maine and other places. If the channel was improved this hay could be brought by coasters at less expense to consumers than it is now brought by rail.

The consumption of lumber amounts to at least 1,500,000 feet, nearly all of which must be brought by rail or teamed in, unless the channel is deepened.

The consumption of granite in Manchester since May, 1886, exceeds 600 tons, nearly all of which came from Rockport, and, with the exception of about 60 tons, all was brought by rail or teamed in at much greater cost than would be necessary if the depth of channel would allow it to be brought by water.

This is also true as regards other building material. The consumption of brick, lime, and cement has increased within a few years at least threefold. This material could be brought by water at reduced cost if depth of channel would allow.

(2) The business and commerce of Manchester would be benefited by the improvement of our harbor. Notwithstanding the injury caused by the filling up of the channel and harbor, which forced the fifty fishing-vessels, formerly engaged in this pursuit, to other ports having a greater depth of water, our town valuation has steadily increased from $1,746,222 in 1877, to $4,826,888 in 1886, and we have reason to believe will continue to increase, especially if the harbor be improved and channel deepened.

We believe that the desired improvement will be of great benefit to the neighboring districts of Magnolia and Beverly Farms, as these towns are obliged to draw their supplies, to a great extent, from distant places, and depend for transportation upon a railroad corporation which can exact its own terms for carrying goods and freight, as it has no competitor in the carrying trade. Supplies could be brought by Manchester Harbor if improved and deepened.

Some years ago our channel had at least 4 feet of water at low tide. Now there is less than 1 foot, and we respectfully suggest that the channel be dredged to a depth of at least 5 feet at low water, and to a width of 100 feet clear.

The rock known as Bow Bell presents a dangerous obstacle to the navigation of our harbor, as it lies directly in the channel, and we suggest that it be removed.

We also respectfully suggest that it would be an advantage to the harbor if a portion of the flats be dredged out, so that there may be an anchorage for boats at all tides. These flats have filled up to a great extent within a few years, and the depth of the harbor gained by a removal of part of them would be greatly to its benefit.

We desire that the harbor be improved as much as possible, and remain, sir,

Yours, respectfully,

JOHN H. CHEEVER,
HENRY T. BINGHAM,
WM. A. STONE,
Selectmen of Manchester.

T. JEFFERSON COOLIDGE.	A. E. LOW.
SAMUEL KNIGHT.	F. K. HOOPER.
DANIEL LEACH.	JOHN ALLEN.
JOHN W. CARTER.	HENRY P. KITFIELD.
THEO. W. SLADE.	GEORGE A. KITFIELD.
C. H. SHELDON.	GEO. C. LEACH.

Col. GEO. L. GILLESPIE.

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SURVEY OF MANCHESTER HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 28, 1887.

GENERAL: In compliance with instructions contained in your letter of March 16, 1887, I have the honor to transmit herewith a report of Mr. Sophus Haagensen on the survey of Manchester Harbor, Massachusetts, made to comply with provisions of river and harbor act approved August 5, 1886.

A tracing is also transmitted showing the limits of the improvement proposed for this harbor determined by the survey.

My preliminary report on this harbor, dated November 20, 1886, gives all the material facts relating to this harbor and the reasons which influenced me in recommending the survey. The only new facts are those which have been revealed by the accompanying chart, which has been prepared from the survey.

The channel from the roadstead to Proctor's Point is everywhere 100 feet wide, with a least depth of 6½ feet mean low water, is unobstructed, and is adequate to the commercial necessities of the port. At Proctor's Point the first important obstruction is met with, which consists of a submerged ledge of rock projecting westward from the west side of Proctor's Point and extending well into the deep-water channel. Another ledge, called the Bow Bell, crops out on the opposite side of the channel a little to the northward and westward of the first ledge. From Proctor's Point to the "Narrows," a distance of 1,400 feet, the channel rapidly shoals to 1½ feet depth mean low water. It is but slightly defined by a few deep and disconnected pools in which the depth varies from 4 to 5½ feet mean low water. From the "Narrows" to the town wharves, a further distance of 2,500 feet, approximately, the bottom of the harbor is practically bare at average low tide. The high-water channel in this last reach is crossed near the town by the Boston and Maine Railroad (eastern division) on a bridge which is provided with a draw opening 28 feet wide in the clear.

It is recommended that a channel be opened from Proctor's Point to the town wharves, which shall be 60 feet wide on bottom and 4 feet deep, mean low water. Its direction is given on the accompanying chart.

In order to take advantage of the pools exterior to the "Narrows," which indicate the direction of the proper channel, an excavation will be required to be made through a portion of Proctor's ledge, leaving the Bow Bell ledge untouched on the west side.

The following is the estimate of the cost of the improvement:

Excavating 46,000 cubic yards of material, sand and loam, in a channel 60 feet wide on bottom, slope 1 on 4, and 4 feet deep mean low water, from Proctor's Point to the town wharves, at 25 cents per cubic yard	$11,500
Blasting and removing 150 cubic yards of rock from the west side of Proctor's ledge, at $10 per cubic yard	1,500
Contingencies for engineering, etc	1,300
Total	14,300

An appropriation of $14,300 is recommended for the improvement indicated in the foregoing report.

The commerce of Manchester at present is nominal.

Attention is invited to the report of Mr. Haagensen for the details of

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the survey, the description of the harbor, and the obstructions to navigation.

Manchester Harbor is in the collection district of Gloucester, Mass., of which Gloucester is the port of entry. The nearest light-house is situated upon Baker's Island, at the entrance to the roadstead, 2¼ miles from Proctor's Point.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., October 31, 1887.

COLONEL: I have the honor to report upon the survey of Manchester Harbor, Massachusetts, made in July, 1887, in pursuance of your instructions; also to submit a map of the survey drawn to a scale of 1:3,000.

TOPOGRAPHY.

The shore-lines shown on the map are, with a few additions of wharves and piers built since 1851, those of the U. S. Coast Survey manuscript map. A copy of this on a scale of 1:10,000 was obtained and enlarged to a scale of 1:3,000. This sheet, used in the field on the plane table, enabled us to orient stations, and to establish a system of ranges for the soundings, so as to correspond with the high-water line.

HYDROGRAPHY.

The area covered by the soundings extends from the 8-foot contour of the outer roadstead up to head of tide-water at Knight's Wharf, and is about 230 acres. Seventy-one lines were run, aggregating in length 8.8 miles, upon which 2,655 soundings were taken. Of this number about one-third were located by plane-table intersections from suitable shore stations. One hundred and forty-four borings were made, principally on the ledge off Proctor's Point and the Bow Bell, of which a special map was made on a scale of 1:500.

The soundings and borings all refer to mean low water.

TIDES.

The range of tide (mean rise or fall) was assumed to be the same as for Gloucester Harbor (8 miles distant), where a full lunation had previously been observed with the following result:

	Feet.
Mean rise or fall of tide	9.0
Extreme low water observed	1.8
Extreme high water observed	11.0

To determine the plane of mean low water, eight consecutive high and low waters were observed on a tide-staff set in the channel near Glass Head. The mean was taken of every two consecutive high and low waters, giving seven values of mean ocean level. From the average of these seven values, 4 5 feet, or half of the mean rise or fall, was deducted to find the plane of mean low water adopted for the survey.

The bench-mark established is shown on the plan; it is the top of the rail of the Eastern Railroad at the draw-bridge, and is 15 feet above mean low water.

DESCRIPTION OF THE CHANNEL AS DEVELOPED BY THE SURVEY.

The entrance to Manchester Harbor is from Massachusetts Bay through the main ship-channel leading to Salem Harbor, which it leaves one-fourth mile west of Baker's Island lights; thence 1 mile almost due north to the center of the roadstead, where there is an anchorage three-fourths of a mile square with a greatest depth of 6 fathoms at mean low water. This roadstead is protected on the south by Great Misery Island, on the west and north by the mainland, and on the east by Gale's Point, Ram Island, and House Island. To the southeast it is exposed.

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One-half mile northeast of the center of the roadstead, in 8 feet depth at mean low water, commences the tidal channel leading to the wharves. It preserves this depth for 3,200 feet, or opposite Proctor's Point; on the 4-foot contour its width is from 200 to 80 feet. Beyond Proctor's Point no navigable channel exists; there are, however, "pot holes" with not to exceed 5 feet in depth. Three thousand feet above Proctor's Point the Eastern Railroad (Gloucester Branch) crosses the harbor on an earthen embankment, with a draw opening 27.9 feet in the clear.

Nine hundred feet beyond the draw is the head of tide-water near the Town Landing. The remainder of the harbor consists of mud flats, mostly in an elevation 2 feet above mean low water. Ledge in and near the channel was only found off Proctor's Point, and at the Bow Bell, which some fifty years ago, it is said, was reduced by blasting to its present level about mean low water.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. GEO. L. GILLESPIE.
Corps of Engineers, U. S. A.

B 14.

PRELIMINARY EXAMINATION OF WINTHROP HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 20, 1886.

GENERAL: In compliance with instructions contained in your letter of September 27, 1886, I have the honor to submit the following report of a preliminary examination of Winthrop Harbor, Massachusetts, provided for in the river and harbor act, approved August 5, 1886.

The harbor is situated in the northeastern part of Boston Harbor, immediately westward of Winthrop Head. It contains 200 acres, approximately, and is dry at low tide, except in a very narrow slough which penetrates the low land to the northward of Snake Island. The mean range of tides is 9½ feet, approximately. There are several wharves along the south shore of the town of Winthrop, from Pulling Point to Winthrop Brook, which at high tide may be reached by vessels drawing not more than 8 to 9 feet. The bed of the harbor is composed chiefly of loam and sand, with occasional bowlders outcropping near Snake Island, but not in the vicinity of the channel. No hydrographic survey has ever been made of the harbor and no money has been spent by any authority for improvement. The inclosed paper, prepared by the selectmen of the town, is an exhibit of the valuation of property of the town, the condition of the harbor, and the character of the improvement solicited by the citizens. The narrow-gauge railroad, which runs through Winthrop to Point Shirley, carries no freight, and all the town supplies, consisting of coal, lumber, brick, and mercantile articles, when not transported by barges, are carted over dirt roads from East Boston or Chelsea.

The population interested in the improvement numbers 5,000 souls, approximately, and the real and personal property is estimated at $2,250,000. The back channel between Point Shirley and East Boston has from 9 to 16 feet at low water, and by opening a narrow channel with 6 feet at low water through Winthrop Harbor to the northward of Snake Island, it will be practicable for small vessels or scows to pass, at all stages of the tide, from Winthrop wharves to Boston wharves by following the cross-channel north of Apple Island and entering the main ship-channel by the Bird Island Channel.

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As Winthrop Harbor forms part of Boston inner harbor, and is only 2 miles distant from the main ship-channel by a navigable channel having 15 feet at low water, I am of the opinion that the citizens of Winthrop are entitled to relief, and that, therefore, the harbor of Winthrop is worthy of improvement.

I recommend a survey of the harbor at an expense not exceeding $600, and an allotment to that extent is asked, provided the project is approved.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

WINTHROP AND ITS WATER COMMUNICATIONS.

The town of Winthrop is in the county of Suffolk, State of Massachusetts, upon whose shores a large and flourishing business might be maintained, which would have a vital relation to the prosperity and growth of the country. It is a subject of national as well as local interest. The many advantages of a sea-port town lie in the saving effected in the transportation of materials such as are used for manufacturing purposes, and would be particularly so in the case of Winthrop, as we have no communication whatever, except one, a narrow-gauge railroad for passengers only. The town has a frontage upon the sea of 7 miles, which, if it could be made available by a channel sufficient to take in light-draught vessels, would greatly lessen the cost of all materials that are used in manufacture or building. The excavation of the channel, it is believed, could be done at a trifling cost compared with the benefits to be derived.

This harbor is free from rocks and obstructions of every kind; its bottom is a bed of mud some 5 feet deep, resting upon sandy soil.

The harbor is well sheltered on all sides, and is a safe place for anchorage while waiting for favorable winds or tide.

The project asked for is the making of a channel, so as to have a depth of 5 feet at mean low water, with a width of 75 feet.

Winthrop, at the present time, is growing more rapidly than any other town in the State. The following will show the increase in population and buildings in Winthrop alone during the past years:

Population in June—	
1880	2,050
1885 (over)	5,000
Number of dwellings in—	
1880	213
1885	558
Increase	345

This does not include stables, stores, hotels, two public halls, and other buildings erected for manufacturing purposes.

In 1874—twelve years ago—there were 430 parcels of land in the town of Winthrop, and at the present time there are 2,509 parcels. There were at that time 168 owners; now there are 664. The number of public streets were 9; now there are 29. The number of private ways then were 16; now there are 89. At that time there were 131 houses; now there are 619.

The following is the increase in valuation within the last two years:

Personal estate in—	
1883	$46,685
1885	59,950
Increase	13,265
Real estate in—	
1883	1,784,595
1885	2,193,500
Increase	408,905

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The above will show a wonderful progress, and all with a very insufficient railroad communication. The present narrow-gauge runs on the north side of the town, and those persons living on the south side have to resort to barges. Three thousand tons of coal are consumed annually, every pound of which has to be carted from East Boston. The same may be said of the building material that is used in the town, such as lime, timber, bricks, and granite. All this heavy material has to be carted over the road, which very naturally increases the cost at least 10 per cent.

A few reasons why this channel should be constructed:

Because it is a public necessity and will prove of great advantage to the town and country.

Because the industry of the town demands it, which is composed at the present time of curriers, torpedo manufacturers, boat-builders, carpenters and builders, wheelwrights, carriage painters, etc.

Because with water communication it is safe to predict that the population and taxation would be doubled inside two years.

Because, in a sanitary point of view, if a channel was cut through the flats it would prove a natural drain, and carry off the refuse matter which is brought in by the tide and left to rot on the flats to the detriment of the health of the inhabitants.

In addition to the before-mentioned reasons why we hope Winthrop Harbor will be deemed worthy of the improvement asked for, we will add that the town of Revere, which adjoins and is tributary to Winthrop for its water communication, contains a population much greater than the latter town, and is joined in Winthrop in the petition to have Winthrop Harbor channel made available for commercial purposes.

EDMUND S. READ,
STEPHEN S. SMITH,
SAMUEL G. IRVIN,
Board of Selectmen, Town of Winthrop, Mass.

SURVEY OF WINTHROP HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 28, 1887.

GENERAL: In compliance with instructions contained in your letter of March 16, 1887, I have the honor to transmit herewith a report of Mr. Sophus Haagensen, assistant engineer, on the survey of Winthrop Harbor, Massachusetts, made to comply with the provisions of the river and harbor act approved August 5, 1886.

A tracing of the survey is also transmitted, upon which has been indicated the proposed project for improvement.

The preliminary report on this harbor, dated November 20, 1886, to which attention is respectfully invited, gives the essential features of the harbor, and my reasons for recommending the survey. It will not be out of place to repeat that the southern side of the flats constituting the harbor is skirted by a back channel having 9 to 16 feet, mean low water, which extends from Point Shirley to East Boston, and which has two navigable connections with the main ship-channel through Boston Harbor.

The harbor, so called, measures 350 acres of tidal flats, which are generally 2 feet above mean low water, over which are scattered a few bowlders, lying chiefly near Snake Island. It is traversed by two small tidal depressions or channels, in which the depth of water varies from 6 feet to 0, mean low water. The greater of these depressions lies on the east side of Snake Island, adjacent to Point Shirley, and the project for the improvement proposes to convert this depression into a navigable channel to connect Rice's Wharf with the back channel, so that vessels of small draught may conveniently reach the town of Winthrop, at all stages of the tide, by way of the Bird Island Channel.

The proposed channel will be 3,900 feet long, 50 feet wide, and 6 feet

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deep, mean low water, and its excavation will require the removal of 64,000 cubic yards of sand and soft clay, at an estimated cost as follows:

Dredging 64,000 cubic yards sand and clay, at 25 cents per cubic yard	$16,000
Contingencies of engineering, etc	1,600
Total	17,600

An appropriation of $17,600 is recommended for the proposed improvement. The population interested in the improvement is 5,000 souls, and the estimated value of the real and personal property represented is estimated at $2,250,000.

I respectfully invite attention to the accompanying report of Mr. S. Haagensen, assistant engineer, for the details of the survey and the general description of the harbor and its approaches.

The existing commerce of the harbor is nominal.

Winthrop Harbor, Massachusetts, is in the collection district of Boston, Mass., of which Boston is the port of entry, and the nearest light-house is situated upon Long Island Head, Boston Harbor, Massachusetts.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 2, 1887.

COLONEL: I have the honor to report upon the survey of Winthrop Harbor, Massachusetts, made in April, 1887, in pursuance of your instructions. Also to submit a map of the survey, drawn to a scale of 1 :6000.

TOPOGRAPHY.

The accompanying map is reduced from the original plot of the survey, which was drawn to a scale of 1 :3000. A base-line 2,150 feet long was measured on the beach connecting Point Shirley with Great Head. Eight triangulation points were located and occupied, and from these the details of the survey were developed. The point K of this survey is the same as the United States Engineer station at Great Head (also U. S. Coast Survey ▲ point); it is marked by a square stone post. By sights from this point to the ▲ point at Governor's Island the survey was connected with the general survey of Boston Harbor.

The high-water and wharf lines from Bartlett's Pier to Rice's Wharf, Snake Island, and part of Point Shirley, were located by us; the rest of the high-water line shown on the map is drawn in by enlarging U. S. Coast Survey manuscript map.

HYDROGRAPHY.

The area covered by our soundings extends from the 18-foot contour of the channel south of the harbor up to the Pile Bridge at Ocean Spray, and is about 350 acres. A fan of twenty lines was laid out, and an aggregate length of 13.1 miles of these lines were run, upon which 2,948 soundings were taken. Of this number 505 were located by transit intersections from shore stations. Nine borings were made in the channel east of Snake Island.

The soundings on the map, selected from the above, refer to mean low water, and are expressed in feet and tenths; those expressed in feet and quarters are taken from the United States Commissioner's survey of Boston Harbor (A. Boschke, 1861), and also refer to mean low water. Two of the lines of the present survey were extended across the channel to Apple Island Flats, to compare with United States Commissioner's map.

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TIDES.

The tides are the same as for Boston lower harbor, viz:

	Feet.
Mean rise or fall of tide	9.4
Extreme low water observed	−2.5
Extreme high water observed	12.2

The tide-staff used in the survey was placed on the United States Wharf at Lovell's Island.

The bench-mark is a copper plug in a stone post 350 feet east of the United States Wharf at Lovell's Island, and is 17 feet above mean low water.

DESCRIPTION OF THE HARBOR AND ITS APPROACHES.

Winthrop Harbor is a tidal harbor, mostly flats in elevation 2 feet above mean low water, inclosed by the high hills of the town on the north and by Great Head and Point Shirley on the east. This triangular area contains about 350 acres south of the Pile Bridge; north of this there is about 110 acres of flats and salt marshes draining into the harbor.

The greatest depression in the flats follows the easterly shore, becomes a low-water channel 1,500 feet below the bridge, and continues to deepen for a length of 2,800 feet to the edge of the flats passing between Snake Island and Point Shirley. For the last 1,600 feet the 2-foot channel is continuous, deepening to 6 feet at the junction with the channel limiting the harbor on the south.

To the west of Snake Island there is another lesser gully. Borings show the flats to consist of sand, mud, and soft clay, to a depth of 8 feet below mean low water. West of Snake Island are many scattered bowlders.

The flats slope abruptly from low water to 18 feet depth, and from the northerly edge of the 1,500-feet-wide channel between Winthrop Harbor and Apple Island Flats. This is the principal water-way for the large tidal basin known as East Boston Flats, with many branching channels and gullies.

It is entered directly from Broad Sound through Shirley Gut with 15 feet at mean low water, and connects with the main ship-channel of Boston Harbor by channels east and west of Apple Island; the former with 15 feet at mean low water to President Roads, 1 mile distant, and the latter with 17 feet at mean low water to upper middle channel, 2 miles distant, *via* Apple Island and Bird Island channels.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. GEO. L. GILLESPIE,
Corps of Engineers, U. S. A.

B 15.

PRELIMINARY EXAMINATION OF DUXBURY HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 8, 1886.

GENERAL: In compliance with instructions contained in your letter of September 27, 1886, I have the honor to transmit herewith the following report of a preliminary examination of the harbor at Duxbury, Mass., provided for in the river and harbor act of August 5, 1886:

Duxbury Bay is one of the three divisions into which Plymouth Harbor is divided, viz: Plymouth Bay, Kingston Bay, and Duxbury Bay. The first two have previously been improved by Government appropriations, but no money has ever been expended upon the channels leading into and through Duxbury Bay.

By resolution of House of Representatives March 9, 1871, an examination or survey of the harbor of Duxbury, Mass., was called for, "with a view to dredging and improving the same, so as to afford greater pro-

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tection and facilities to commerce," etc. (Report Chief of Engineers, 1872, page 963.)

The town of Duxbury covers part of the Kingston Bay, so called, and it is stated in the report of the local engineer, December 1, 1871, that the petitioners of Duxbury, in asking for the improvement of their harbor, had in view the enlargement, at Splitting-Knife Bar, of the Miles or South Channel, extending westward from the Cow Yard by the south point of Captain's Hill. Owing to the small amount of commerce at the wharves located on Duxbury Bay proper, to which access was given by the channel on the east side of Captain's Hill, and the small draught of the vessels, chiefly in the fishing trade, which entered that part of the harbor, and for other reasons, the local engineer did not recommend the improvement of the channel leading into Duxbury Bay, which was estimated to cost $66,000.

The appropriation of June 10, 1872, of $10,000, and that of March 3, 1873, of $10,000, were applied in the South Channel. No other appropriations have been made except for the improvement of Plymouth Bay. Duxbury Bay is not so important commercially as the other bays; still it has a good, wide channel, affording 12 feet depth mean low water to within 1 mile of the principal wharf, and affords a respectable anchorage for vessels when the Cow Yard is full. If the channel were extended with 6 feet depth mean low water, so that the principal wharf of the town could be reached, it is believed that all the trade of the town would be concentrated there, to the benefit and advantages of the citizens, and that many vessels would use it, by which freight charges would be reduced on coal, lumber, and other supplies, which form the principal foreign articles of consumption in the town.

The harbor "is worthy of improvement" as one of the tributaries of the main harbor of Plymouth, Mass.

The channel improvement, for which an estimate was given in 1871, extended from the wharf on the south side of Duxbury Point, in the northern part of the harbor, to the 6-foot curve. It was 2,000 feet long, 150 feet wide, and 6 feet deep, mean low water. As sixteen years have elapsed since the survey of 1871, and since it is probable many changes have occurred in the upper harbor of Duxbury, I would recommend that an examination be made of the existing channel inside the 6-foot curve to determine the direction to be given to the improved channel.

The allotment recommended for this purpose is $400.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF DUXBURY HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 28, 1887.

GENERAL: In compliance with instructions contained in your letter of March 16, 1887, I have the honor to transmit herewith a report by Mr. Sophus Haagensen, assistant engineer, on the survey of Duxbury Harbor, Massachusetts, made to comply with the provisions of river and harbor act approved August 5, 1886.

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The accompanying tracing gives the details of the authorized examination of the existing channel through the inner harbor of Duxbury, inside or north of the 6-foot curve, upon which is located the direction to be given to an improved channel to a selected wharf at Duxbury.

An outline tracing of Plymouth, Kingston, and Duxbury bays, combined, is also transmitted, to render intelligible the report of the local engineer, December 1, 1871. (Report Chief of Engineers, 1872, page 963.)

The Cow Yard, inside and near the sea entrance to these bays, is the anchorage common to all. It is marked by the Duxbury Pier Light and day beacon, and has in places a depth of 12 fathoms at mean low stage. Starting from this common ground, the improvements made by the Government in past years have been to the southward in the direction of Plymouth, or northward in the direction of Kingston.

The channel leading to the northward through Duxbury Bay has never been improved, though the conditions of protection afforded by an outer beach are as favorable as in the case of the Plymouth Harbor improvement.

Abreast and westward of Clark's Island the Duxbury Channel separates into two channels. The Beach Channel is broad and deep, follows close to the beach, and has its depth maintained by the tidal scour from Back River. This channel is remote from the town, and has no wharves which could be conveniently converted into commercial use.

The westward channel is also amply wide and deep for vessels drawing 18 feet to within one-half mile of the southern end of the town, when it separates into two branches, the eastern branch terminating in the 6-foot curve below Knapp's Wharf, and the western terminating in the same curve below the town wharf. In the Report of 1871 an estimate was submitted for connecting this eastern branch with Knapp's Wharf at a cost of $66,000. It was this improvement which I had in my mind when the preliminary report of November 8, 1886, was submitted. But inasmuch as the property upon which Knapp's Wharf is located has lately changed hands, and that shore will no longer be used for commercial purposes, I have during the survey examined the shore upon which the town is built, and now present a project for a channel which will communicate with its principal wharf.

I have chosen the western branch of the Duxbury Channel for improvement, for the reason that the excavation will be less on that side, and also because the axis of the improved channel will be more nearly in the direction of the ebb currents than in the case of a channel excavated to connect the town wharf with the eastern branch.

The proposed channel will be 3,600 feet long, 60 feet wide, and 6 feet deep, mean low water, and its improvement will require the excavation of 48,000 cubic yards of material, scow measure, at an estimated cost as follows:

Dredging 48,000 cubic yards of material, scow measurement, at 25 cents per cubic yard	$12,000
Contingencies for engineering, etc	1,200
Total	13,200

A comparison of the surveys of 1871, 1875, and 1887 indicates that the channel, when once opened, will probably not deteriorate more rapidly than similar tidal channels.

An appropriation of $13,200 is recommended for the improvement.

Duxbury is not an important commercial point; but it is believed that the proposed channel will give great relief to the town by reduc-

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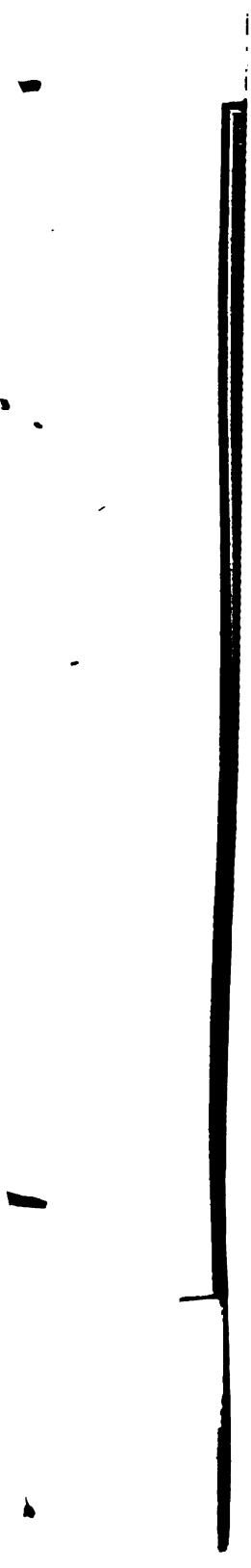

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ing the cost of transportation of such articles as coal, lumber, lime, and building materials, which enter into daily consumption.

I respectfully invite attention to the report of Mr. Haagensen, assistant engineer, for the details of the survey and for the general description of the harbor.

Duxbury is in the collection district of Plymouth, Mass., of which Plymouth is the port of entry. The nearest light-house is the Duxbury Pier Light, situated in the Cow Yard anchorage.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER'S OFFICE,
Boston, Mass., November 4, 1887.

COLONEL: I have the honor to report upon the survey of Duxbury Harbor, Massachusetts, made in August and September, 1887, in pursuance of your instructions; also to submit a map of the survey drawn to a scale of 1 : 6000.

TOPOGRAPHY.

The accompanying map is reduced from the original plot of the survey, which was drawn to a scale of 1 : 3000. A base line 2,200 feet long was measured from Knapp's Wharf eastward along the shore of Powder Point.

Fourteen triangulation points were located and occupied, and from these the details of the survey were developed. The point Duxbury Belfry is the same as in United States Engineer's Survey of 1871 (and of the U. S. Coast Survey map); by sights from this station to South Gurnet Light the present survey was connected with former surveys.

The high-water line, shown on the map, is essentially that of the U. S. Coast Survey map, the only change being a dike built across Blue River, which, with Knapp's Wharf and some scattered points of the high-water line, were located by us.

HYDROGRAPHY.

The area covered by our sounding is the upper northwest corner of the harbor, and amounts to 750 acres, or about 1¼ miles from north to south by nearly a mile from east to west, so as to include the main channel with its branches. Sixty ranges were established and an aggregate length of 28.6 miles of these lines run, upon which 6,663 soundings were taken; of this number 1,102 were located by transit intersections from shore stations. Below the area covered by the soundings the channel as far as the Cow Yard was "swept;" no obstructions were found. The soundings, expressed in feet and tenths, refer to mean low water.

TIDES.

A tide-staff was set in the main channel, and by eight consecutive high and low water observations seven values found for mean ocean level. From the average of these were deducted 4.65 feet (or one-half of mean rise or fall, 9.3 feet), giving mean low-water level.

A bench-mark was established on Knapp's Wharf (shown on map) and is a drill-hole in the coping stone in elevation 9.85 feet above mean low water.

CURRENT OBSERVATIONS.

The tracks of free floats set adrift near the wharves were followed both on ebb and flood tide. The velocity of current is almost imperceptible in this part of the harbor, the maximum observed being .4 foot per second on half and three-quarter ebb, and .3 foot per second on three-quarter flood. Most of the floats on the ebb tide drifted towards the main channel, although some, during the latter part of the ebb, turned the projecting point opposite Knapp's Wharf and followed the shore southward.

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DESCRIPTION OF CHANNEL.

The entrance to Duxbury Harbor is from Cape Cod Bay through the "Main Ship-channel" leading from Gurnet Lights for a distance of 3 miles to Duxbury Pier Light in the Cow Yard, which is the roadsteads common to Plymouth, Kingston, and Duxbury Harbors; this channel runs due west, is straight, almost one-half mile wide, and passable for vessels of the deepest draught. The Cow Yard is circular, about three-fourths of a mile in diameter, and the greatest depth is 12 fathoms at low water. From Duxbury Pier Light the main channel of Duxbury Harbor runs in a northerly direction, tapering from a width of 600 feet to 200 feet on the 18-foot curve at the point where the present survey began, distant 2¼ miles from Duxbury Pier Light, or 5¼ miles from the Gurnet. About midway in this reach, or abreast of Clark's Island, is the junction with the Beach Channel, which carries off the water of Back River, the drain from the extensive marshes north of Powder Point.

From the initial point of the survey the 18-foot channel is continuous for 3,600 feet; the 12-foot (from 300 to 200 feet wide) for a distance of 5,000 feet; the 6-foot channel extends to 6,500 feet, where the channel through the flats becomes very circuitous and shallow, and practically ends at 9,000 feet, or opposite Knapp's Wharf. Five hundred feet north of the initial point a 10-foot channel branches off to the west and north to a distance of 3,500 feet. At 3,800 feet the 6-foot channel stops, although there are many "pot-holes" with 6 feet depth between this point and the Town Landing, 7,400 feet distant.

Outside of the above-described channel the surveyed area is mud-flats in an average elevation of mean low water, running almost entirely dry at an extreme low water.

Borings made in 1871 show these flats to consist of sand and mud overlying hard clay, which latter was struck in the following depths: 5¼ feet, 11½ feet, 2½ feet, and 6¼ feet below mean low water in four representative sections of this part of the harbor.

The survey shows no change in the channels or flats, as developed by survey of 1871 and by U. S. Coast Survey of 1867 and 1870.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. GEO. L. GILLESPIE,
Corps of Engineers, U. S. A.

B 16.

PRELIMINARY EXAMINATION OF WELLFLEET HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 8, 1886.

GENERAL: In compliance with instructions contained in your letter of September 27, 1886, I have the honor to transmit herewith the following report of a preliminary examination of the harbor at Wellfleet, Mass., provided for in the river and harbor act of August 5, 1886.

This harbor is situated near the northern extremity of Cape Cod, and is the best and most sheltered harbor on the cape, except that of Provincetown. It is especially frequented by mackerel fishermen, whose fleet numbers over one hundred vessels, but this number is largely increased by other vessels which come irregularly. The draught of some of the vessels is 10 feet and over, and under present conditions they can only make the harbor at half-tide.

The value of the annual fish yield exceeds $500,000.

By act of Congress January 31, 1871, a survey of this harbor was made June, 1871, and a report submitted November 3, 1871 (Report Chief of Engineers, 1872, page 969). The report embodied a project for excavating a channel to give access to Central and Commercial wharves at Wellfleet 2,060 feet long, 150 feet wide, and 4 feet deep, at an estimated cost of $30,000.

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By act June 10, 1872, an appropriation of $5,000 was made for the improvement, which sum was expended in 1872–'73 in the complete removal of Channel, Mayo, Bay, Lobster, and Lumpfish rocks.

The survey of 1871 only covered that portion of the upper bay which extends north of "Deep Hole," about 1 mile from the town wharves. The obstructions of which mariners now complain, in addition to those mentioned in report of 1871, are the sand-shoals in the lower bay (all the known bowlders near the channel have been removed) at the entrace and inside, opposite Billingsgate light-house.

I think the harbor "worthy of improvement," and respectfully recommend that the portion of the harbor surveyed in 1871 be re-examined with the view of ascertaining the changes which have taken place since that survey, and that special surveys be made of the two shoals between Billingsgate light-house and the deep water of the outer bay. The object of the first is to make an estimate for a channel with 6 feet depth, mean low water, to the town wharves, and of the second for providing an entrance 12 feet deep, mean low water, for the mackerel fleet, to a secure harbor of refuge in the inner harbor at all stages of the tide.

The cost of the survey is estimated at $1,500. An allotment of that sum for the purpose indicated is respectfully recommended.

A sketch* plan of Wellfleet Harbor is inclosed herewith.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF WELLFLEET HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 28, 1887.

GENERAL: In compliance with instructions contained in your letter dated March 16, 1887, I have the honor to transmit herewith a report of Mr. Sophus Haagensen, assistant engineer, on the survey of Wellfleet Harbor, Massachusetts, made to comply with the provisions of the river and harbor act approved August 5, 1886.

A tracing of the chart prepared from the survey is also transmitted, upon which are drawn the limits of the improvement proposed for the harbor.

Wellfleet is situated on Cape Cod Bay, on the south shore of the peninsula of Cape Cod, 12 miles southeast of Provincetown Harbor. It is the best and most sheltered harbor on the cape, except that of Provincetown, and is the resort of the principal mackerel fleet of the coast, which fleet numbers over one hundred vessels, besides of other fishermen whose sail vary in number and kind.

The catch of fish, one year with another, averages 20,000 barrels, at an estimated valuation of $100,000.

The harbor is divided, practically, into two parts:

First. The inner harbor, which includes the part north of Smalley's Bar, and is known as the Deep Hole anchorage, from which the cargoes are lightered to the wharves of the town. This anchorage is completely protected and safe, as the bounding shores are all above the highest water level. The area included within the 6-foot curve is 900 acres, and is distant 3,700 feet, at the nearest point, from the town

* Omitted.

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wharves. The 12-foot channel, which traverses nearly the whole of this basin. is 400 feet wide, and practically terminates in the Deep Hole.

Second. The outer harbor, which includes the outer anchorage and the approach over Stony Bar. At very high stages of the tide this anchorage becomes a wide estuary of Cape Cod Bay, as the shoals on the west side, including Billingsgate Island, are wholly submerged. Safe anchorage at such times can only be secured by going into the inner harbor. Billingsgate Island and Lieutenant Shoal divide the outer harbor into two basins; the outer one is wide and shoal, having a width between the 12-foot curves of 3,000 feet and a maximum depth of 21 feet; while the inner one is narrow and deep, having a width between the 12-foot curves of 1,000 feet and a maximum depth of 34 feet. The connecting passage of these two basins, where the width is only 300 feet and the depth 14 feet, is regarded by mariners as the part of the channel which affords the most difficult navigation. A proper location of the buoys will make the access easy and convenient.

The outer bar, known as Stony Bar, offers no obstruction; it has 15½ feet at mean low water, and the channel over it, between the 12-foot curves, has a width of 1,400 feet.

It has been before stated that the anchorage of the inner harbor is good and sheltered; but it must be noted that it does not meet all the commercial necessities of the harbor, inasmuch as it has no connection for vessels with the town wharves at low tide. From the margin of the Deep Hole the bottom rises gradually until it becomes exposed at the wharves at low tide. This fact very much impairs the anchorage commercially. It is proposed to ameliorate the conditions in a degree by excavating a channel 4,200 feet long, 100 feet wide at bottom, and 6 feet deep, mean low water, from the Deep Hole to the wharves.

The estimate of the cost is as follows:

Dredging 86,000 cubic yards of material, scow measurement, at 25 cents per cubic yard	$21,500
Contingencies for engineering, etc.	2,500
Total	24,000

An appropriation of $24,000 is recommended for this improvement.

When this new channel is opened and the buoys in the outer harbor are properly located, the inner harbor will be equal to every demand upon it for depth of water and ease of access.

I invite attention to the accompanying report of Mr. Haagensen, assistant engineer, for the details of the survey and the description of the harbor.

I also invite attention to my preliminary report on the harbor, dated November 8, 1886.

My thanks are due to Mr. Simeon Atwood, deputy collector of customs, for the accompanying statement giving the commercial statistics of the harbor, viz:

The following is a report for the harbor of Wellfleet, showing the amount of revenue collected during the fiscal year ending June 30, 1887, the number of entrances and clearances, the tonnage and character of the same, and other items showing the amount of commerce and navigation, both foreign and domestic, to be benefited by the completion of each particular work:

Foreign clearances	3
Coastwise entries of foreign salt	11
Revenue collected	$166.40
Salt received in bond (998,900 pounds)	$1,012.00
Lumber landed (240,000 feet)	$3,500.00
Coal landed (1,221 tons)	$6,105.00
Cured mackerel landed (3,105 barrels)	$41,704.27

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Tonnage employed.	Gross.	Net.
Wholly in coasting	3,053.00	2,900.39
Coasting and fishing	2,595.65	2,465.82
Total tonnage	5,648.65	5,366.21

Vessels licensed for coasting; vessels licensed for fishing, 44.

Respectfully submitted.

SIMEON ATWOOD,
Deputy Collector.

P. S.—I most respectfully suggest that the year ending June 30, 1886, was an off year so far as the fishing interests and products are concerned. To show the products for years previous I append the following:

Catch of mackerel.

Years.	Barrels.	Values.
1881	31,365	$171,059.00
1882	30,133	177,173.27
1883	14,175	120,845.10
1884	32,168	155,187.19
1885	19,676	102,377.23
1886	3,105	41,704.27
1887 (estimate)	6,000	90,000.00

Consequently the amount of salt received would be correspondingly large.

Respectfully,

SIMEON ATWOOD,
Deputy Collector.

Wellfleet is in the collection district of Barnstable, Mass., and the nearest light-house is located upon Billingsgate Island.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. SOPHUS HAAGENSEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Boston, Mass., November 11, 1887.

COLONEL: I have the honor to report upon the survey of Wellfleet Harbor, Massachusetts, made in September and October, 1887, in pursuance of your instructions; also to submit a map of the survey drawn to a scale of 1: 20,000.

TOPOGRAPHY.

The accompanying map is reduced from the original plot of the survey, which was drawn to a scale of 1 :5,000. A base-line, 5,580.66 feet long was, measured from Mercantile Wharf westward along the beach toward Herring River. Twenty-two triangulation points were located, of which nine were occupied, and from these two hundred and fourteen triangulation angles were measured; the most important were repeated not less than four times.

The high-water line is essentially that of the U. S. Coast Survey map, 1851, with exception of the wharves in Wellfleet and the shore-line of Billingsgate Island. The present island is much reduced in size, and has been beaten to the eastward since 1851 about 800 feet. The outer Billingsgate Island (former site of the light-house) has now disappeared, and the highest part of the remains, dry at half-tide (Sunken Island), is 600 feet east of its position in 1851.

HYDROGRAPHY.

The area of Wellfleet Harbor is about 5 miles north to south by 3 miles from east to west, and amounts to 9,811 acres. Of this area about 2,240 acres were covered by our

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soundings, so as to develop the channel. In the southerly part of the harbor the channel through Stony Bar and that between Billingsgate Island and Lieutenant Island Shoal were specially examined by closer soundings; in the northerly part, from Smalley's Bar to the town wharves, most of the area was covered by close soundings. One hundred and thirteen lines of soundings were established. An aggregate length of 60 miles of these were run, upon which 11,717 sounding were taken; of this number 1,867 were located by observations from or upon shore stations with transit or sextant. The soundings expressed in feet and tenths, are selected from the above; those in feet are taken from the U. S. Coast Survey manuscript map; they all refer to mean low water.

TIDES.

Two tide-staves were established, one at Central Wharf, for the upper harbor, and one in the channel off Billingsgate Island, for the survey of the lower harbor; they both had their zero at mean low water, as determined in 1871, and which is marked by the top of stone monument N. 8, 14.76 feet above mean low water. When set in 1871, monument 8 was 55 feet southeast of Mayo's Beach Light; since then the light has been moved north about 100 feet.

	Feet.
Mean rise or fall of tide	11.2
Mean rise or fall of spring-tide	13.3
Mean rise or fall of neap-tide	9.4

DESCRIPTION OF HARBOR AND SHIP-CHANNEL.

The harbor may be divided into the upper and lower harbor by a line through Smalley's Bar and Lieutenant Island.

The upper harbor is well sheltered on the east and north by the high hills of the mainland, and on the west by Great Island, Great and Little Beach hills.

The lower harbor is well protected against east winds by the high land of Eastham, but in the other directions much exposed, especially at high water of spring-tides, when even Billingsgate Island is overflowed.

The lower harbor has two basins: Basin 1, between Stony Bar and Lieutenant Island Shoal; basin 2, between Lieutenant Island Shoal and Smalley's Bar.

The upper harbor has two basins: Basin 3, between Smalley's Bar and Quahaug Ground; basin 4, or Deep Hole, between Quahaug Ground and the flats, gradually shoaling towards the wharves.

The channel from Cape Cod Bay through Stony Bar to Basin 1 is 4,000 feet long from the 18-foot curve on the outside, to the 18-foot hole inside of the bar. The black buoy on the bar is half-way between the 18-foot depths, and its distance from the wharves in town is 6 miles, measured on the axis of the ship-channel. There is a 15-foot channel through Stony Bar of a least width of 700 feet; the 12-foot channel is not less than 1,400 feet wide. Basin 1 is on the 12-foot curve, 3,000 feet in width by 4,000 feet in length. The greatest depth found is 21 feet, and the average depth is 15 feet at mean low water. From this basin three dangerous rocks were removed in 1872–'73, viz:

Channel Rock, having only 1.8 feet water over it at mean low water; Lobster Rock having only 4.5 feet water over it at mean low water, and Lumpfish Rock having only 3.5 feet water over it at mean low water.

The channel between Basin 1 and 2 is the one most complained of by the pilots. It runs in a northwesterly direction to a line between Billingsgate Island Light and the red buoy at the extremity of Lieutenant Island Shoal; this buoy is 4¼ miles from the wharves; 2,000 feet below the buoy is the most difficult place; there is a least width of 300 feet on the 12-foot contours, and 14 feet depth can be carried through the channel, which deepens rapidly above; half-way to the buoy the 18-foot channel commences; off the red buoy the depth is 27 feet at mean low water.

Basin 2 is the deepest part of the harbor. From the red buoy at Lieutenant Island Shoal to the black buoy off Smalley's Bar (2¼ miles from the wharves) there is a straight 18-foot channel, averaging 1,000 feet in width, and having from 4 to 5¼ fathoms of water in it at mean low water.

Basin 3 joins Basin 2 at the black buoy off Smalley's Bar. The 18-foot channel at this junction is not less than 400 feet wide. Basin 3 measures on the 12-foot contour 2,000 by 3,000 feet. The greatest depth is 21 feet, while the average is 16 feet at mean low water. From this basin two dangerous rocks were removed in 1872–'73, viz:

Mayo's Rock, having only 2.7 feet over it at mean low water, and Bay Rock, the top of which was 3.4 feet above mean low water.

The Quahaug Ground separates Basin 3 from Basin 4 (Deep Hole); the channel connecting the two begins one-half mile northwest of Smalley's Bar Buoy, and runs due

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north for about 1 mile, where the continuous 12-foot curve ends, distant about 1 mile from the wharves. The lower half of the 12-foot channel averages 500 feet in width, the upper half 300 feet.

The greatest depth in Deep Hole is 13 feet, and the 6-foot contour extends to within 3,600 feet from Central Wharf. With exception of one "pot hole" one-half mile from the wharves, with not to exceed 7 feet at mean low water, the flats shoal gradually to the town.

Herring River on the west, and Town Creek on the east, empty into the head of the harbor, draining large areas of salt marshes in the town.

With the exception of the development of details by more numerous soundings, no material change in the upper harbor can be seen by comparison with former surveys; but the present detailed surveys of the bars in the lower harbor (not surveyed in 1871), shows practicable channels through them of such widths and depths as are stated above.

Very respectfully, your obedient servant,

SOPHUS HAAGENSEN,
Assistant Engineer.

Lieut. Col. GEO. L. GILLESPIE,
Corps of Engineers, U. S. A.

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APPENDIX C.

IMPROVEMENT OF HARBORS AND RIVERS ON THE SOUTHERN COAST OF MASSACHUSETTS AND IN RHODE ISLAND AND CONNECTICUT.

REPORT OF MAJOR WILLIAM R. LIVERMORE, CORPS OF ENGINEERS, OFFICER IN TEMPORARY CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, 1, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor of Refuge at Hyannis, Massachusetts.
2. Harbor of Refuge at Nantucket, Massachusetts.
3. Wood's Holl Harbor, Massachusetts.
4. Wareham Harbor, Massachusetts.
5. Westport Harbor, Massachusetts.
6. Taunton River, Massachusetts.
7. Warren River, Rhode Island.
8. Pawtucket River, Rhode Island.
9. Providence River, and Narragansett Bay, Rhode Island.
10. Removal of Green Jacket Shoal, Providence River, Rhode Island.
11. Newport Harbor, Rhode Island.
12. Harbor of Refuge at Block Island, Rhode Island.
13. Little Narragansett Bay, Rhode Island and Connecticut.
14. Pawcatuck River, Rhode Island and Connecticut.
15. Harbor of Refuge at Stonington, Connecticut.

EXAMINATIONS AND SURVEYS.

16. New Bedford Harbor, Massachusetts.
17. Taunton River, Massachusetts.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., July 2, 1888.

SIR: I have the honor to submit herewith annual reports for the year ending June 30, 1888, for river and harbor works temporarily in my charge.

This office was assisted during the year by Assistant Engineer Edward Parrish; by Assistant Engineer Frank I. Angell from July 21 to August 5, 1887, and by Assistant Engineer John H. Rostock from August 6, 1887, to June 30, 1888.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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C 1.

HARBOR OF REFUGE AT HYANNIS, MASSACHUSETTS.

The harbor of Hyannis lies on the south shore of the peninsula of Cape Cod, about 15 miles to the westward of the heel of the cape, and is an important harbor of refuge.

The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement it was an open roadstead, exposed to southerly storms.

PLANS OF IMPROVEMENT.

In the years 1827–1838 a breakwater of riprap granite 1,170 feet long was constructed, covering an anchorage of about 175 acres, the entrance to which has a depth of about 15½ feet. In the years 1852–1882 extensive repairs were made in increasing the width of its base and the size of the stone forming its sides and top.

The depth of water inside the breakwater is insufficient for many vessels that seek the harbor for refuge, and Colonel Elliot's project for the improvement of the harbor, published in the Report of the Chief of Engineers for 1885, volume 1, pages 560 and 619–621, contemplated dredging the area protected by the breakwater to a depth of 15½ feet at mean low water.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on this work up to June 30, 1887, was $124,163.18. The breakwater had been completed according to the original project and the subsequent plans for strengthening it, and the 15½-foot anchorage area had been increased by about two acres.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work was in progress, under the project for the expenditure of the appropriation of $10,000 of August 5, 1886, approved by the Chief of Engineers, which consisted in beginning the work of dredging at the eastern side of the area to be deepened, and continuing it as far to the westward as the funds available would permit. The work was continued up to September 30, 1887, when it was suspended on account of the weather.

The contractor has failed to resume operations, and the time for the completion of the contract expired on June 30.

Mr. Thomas A. Churbuck was the local inspector of the work of dredging.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $3,724.19. The result has been the excavation of 21,389 cubic yards of mud and sand and the increase of the 15½ foot anchorage area protected by the breakwater by about 4.9 acres.

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WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the dredging to a depth of 15½ feet in the area limited on the west by a line running due north from the western end of the breakwater and on the north by a line running parallel to the breakwater and distant 1,500 feet from it, leaving a berm of 100 feet along its northern side.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

The execution of the project above referred to, of deepening the anchorage area inside the breakwater, will be continued.

Hyannis Harbor is in the Barnstable collection district, and Barnstable is the nearest port of entry. The amount of revenue collected at Barnstable in the last fiscal year was $570.02.

The main value of the harbor is for a harbor of refuge. The nearest light-house is Hyannis Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1887, amount available		$9,194.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,369.11	
July 1, 1888, outstanding liabilities	355.08	
July 1, 1888, amount covered by existing contracts	5,449.39	
		9,173.58
July 1, 1888, balance available		20.82
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,020.82
Amount (estimated) required for completion of existing project		25,662.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		25,662.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. A. F. Lothrop, Hyannis, Mass.]

IMPORTS.

Coal	tons..	8,071
Grain	bushels..	125,000
Brick		25,000
Lumber	feet..	1,250,000
Lime	barrels..	300

EXPORTS.

Iced fish	barrels..	800

VESSELS IN HARBOR DURING THE YEAR.

Sailing	1,400
Steam	225

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C 2.

HARBOR OF REFUGE AT NANTUCKET, MASSACHUSETTS.

Nantucket Harbor is the only one between the harbors of Martha's Vineyard (Vineyard Haven and Edgartown) and Provincetown, a distance of about 100 miles, except the small harbor of Hyannis, on the other (the north) side of Nantucket Sound, the navigation of which is intricate and dangerous by reason of numerous shoals. Nantucket Harbor has deep water inside, and the object of the improvement is to make it a harbor of refuge for vessels plying between ports north and south of Cape Cod, estimated to be 30,000 annually. In the memorial to Congress, on which the first appropriation for this harbor of refuge was based, it was stated that more than 500 vessels had been wrecked in the vicinity of the island.

The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the commencement of the present work there was a shoal about 1½ miles in width outside the entrance, through which shoal the channel or line of best water was only about 6 feet deep and very crooked and subject to changes in location.

PLANS OF THE WORKS.

The present approved project is to construct jetties of riprap stone projecting from either side of the present entrance to the harbor, for the purpose of concentrating the strength of the tidal currents, and excavating a channel of 15 feet depth by scour, and at the places where the full depth required will not be reached by this means to complete the work by dredging. A plan of the works may be found in the Report of the Chief of Engineers for 1885, volume 1, page 578.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on this project up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $111,531.77, and the result was the construction of the west jetty to a point 3,955 feet from the shore and the east jetty to a distance of 330 feet from the initial point on the shore, which is the outer end of the middle of the three northwest spurs built on Coatue Beach some years ago, and the foundation was laid and the jetty partially completed for an additional distance of 56 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of the construction of the east jetty under the approved project was in progress, and was continued until October 1, 1887. The contractor has failed to resume operations as required by his contract.

Soundings were taken over the area between the east jetty and Brant Point, but show no material change in the depth of water beyond that already reported.

Until the two jetties are completed and a light-house erected on one of them the end of the west jetty will be a source of danger to vessels

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entering and leaving the port at night. In order to avoid this danger as far as possible, a temporary light has been established at the end of that jetty, which has been faithfully maintained during the year.

Mr. C. O. Abell was local inspector of the work of the construction of the east jetty.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $7,618.92. The construction of the east jetty was continued and fully completed to a distance of about 385 feet from the initial point on the shore, and the foundation was laid and the jetty partially completed for an additional distance of 200 feet. During the fiscal year 2,941.5 tons of stone were placed in the jetty.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the east and west jetties, and the excavation by dredging of so much of the channel as may not be excavated by tidal scour.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to continue the construction of the east jetty as far as the available funds will permit.

Nantucket is in the Nantucket collection district, and is a port of entry. The amount of revenue collected at Nantucket in the last fiscal year was $40.15. The value of the harbor is mainly as a harbor of refuge. The nearest light-houses are Nantucket Cliff and Brant Point lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1887, amount available		$13,468.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$6,926.68	
July 1, 1888, outstanding liabilities	692.24	
July 1, 1888, amount covered by existing contracts	5,849.31	
		13,468.23
Amount appropriated by act of August 11, 1888		20,000.00
Amount (estimated) required for completion of existing project		230,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. Albert A. Gardner, collector of customs, Nantucket, Mass.]

IMPORTS.

Coal	tons	6,830
Grain	bushels	15,000
Flour	barrels	4,500
Hay	tons	180
Lumber	feet	2,000,500
Brick		320,000
Lime	barrels	1,050
Cement	do	320
Wood	cords	680
Salt	bushels	1,000
General merchandise	tons	4,006

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C 3.

IMPROVEMENT OF HARBOR OF WOOD'S HOLL, MASSACHUSETTS.

This harbor is on the north side of Vineyard Sound and is divided into Great Harbor and Little Harbor. The name Wood's Holl is also applied to the adjoining strait, which connects Vineyard Sound with Buzzard's Bay. The site of the works is Great Harbor, Wood's Holl. The mean rise and fall of the tide is about 2 feet.

ORIGINAL CONDITION.

Before the improvement the site of the present works was a submerged point of land extending from the shore of the harbor.

PLANS OF IMPROVEMENT.

The adopted project for the improvement of Great Harbor, Wood's Holl, was for the construction of retaining-walls on the shore, a hollow pier and wharves for the use of the United States Fish Commission, and to serve also as a coaling station for vessels of the Revenue Marine and other branches of the public service, and as a harbor of refuge. A plan of the works may be found in the Report of the Chief of Engineers for 1884, vol. 1, page 598. Also, for the removal of a dangerous rock in the strait of Wood's Holl.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on these works to June 30, 1887, was $91,955.50. The retaining and pier walls and the dredging of the interior of the hollow pier and the berths for public vessels had been completed, and all the wharves as projected had been completed, except a small amount of planking on the coal-wharf extension. The dangerous rocks in the strait had been removed, and the small amount of dredging in the rear of the coal-wharf extension had been completed.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the fiscal year the work under the approved project for the improvement of the harbor at Wood's Holl was in progress, and was completed July 20, 1887.

Mr. Frank I. Angell was the local inspector of the work at Wood's Hoil.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities oustanding June 30, 1888, was $451.16. The pier and retaining-walls have been constructed, the basin and berths for vessels have been dredged, and all the wharves as projected have been completed, the dangerous rocks in the straight have been removed, and the small amount of dredging in the rear of the coal-wharf extension has been completed.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The completion of the work under the contract with William M. Molthrop & Co., dated September 27, 1886, and the supplemental contract, dated November 12, 1886, finished the improvement as far as projected.

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OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

No work is proposed for the fiscal year ending June 30, 1889.

Wood's Holl is in the Barnstable collection district. New Bedford is the nearest port of entry. The amount of revenue collected in the last fiscal year was, at Barnstable, $570.02, and at New Bedford, $58,865.60. The nearest light-house is Nobska Light; the nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1887, amount available	$451.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	451.16

COMMERCIAL STATISTICS.

[Furnished by A. F. Shriverick, Wood's Holl, Mass.]

The receipts and shipments by vessels have been about as follows during the past year:

Cargoes of coal aggregating 6,000 tons	25 to 30
Cargoes of spiles, wharf material, etc	4
Cargoes of lumber	4
Cargoes of barrels	4
Cargoes of completed fertilizer, phosphate, rock, brimstone, nitrate of soda, fish scraps, and other materials used in the manufacture of fertilizers, aggregating about 25,000 tons	75

C 4.

IMPROVEMENT OF WAREHAM HARBOR, MASSACHUSETTS.

This harbor is an estuary at the head of Buzzard's Bay. The object of the improvement is to deepen and widen the channel leading from Buzzard's Bay to Wareham, the industries of which, and of several towns in the vicinity with which it is connected by rail, are chiefly the manufactures of iron, and depend largely on transportation by water of the material used therein. The commerce of Wareham is carried on in sailing vessels, and the channel is to be made a beating channel for such vessels.

Another object of the improvement is the raising of Long Beach, over which the sands from the bay were washed into the harbor. The mean rise and fall of the tide is 4 feet.

ORIGINAL CONDITION.

Before improvement the ruling depth in the harbor was about 7 feet at mean low water, in a narrow and very crooked channel. Long Beach, a narrow sand spit at the mouth of the harbor, was washed and abraded by the waves and currents at high water, and the material was carried into and shoaled the channel inside.

PLANS OF IMPROVEMENT.

The original approved project of 1871 for the improvement, and its subsequent modifications, provides for a channel 250 feet wide and 10

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feet deep at mean low water from Barney's Point down to the entrance to the harbor. Above Barney's Point the width of the channel is to be 350 feet, with the same depth, 10 feet, as below that point. The plan includes, also, the raising and strengthening of Long Beach, of which a large portion was submerged at low water, to carry it above the storm waves and currents and to hold it there in order to prevent the filling of the improved channel above by material abraded from the beach.

A plat of Wareham Harbor, showing the lines of the channel now being excavated, may be found in the Annual Report of the Chief of Engineers for 1885, vol. 1, page 586.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The total amount expended on the improvement up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $69,704.14, and the result was that the channel in the upper part of the harbor in front of the wharves was carried to its full width and completed, and the eastern half of the second and third reaches below the wharves and about one-fourth of the fourth reach, which extends to Barney's Point, were excavated to the full depth of 10 feet below mean low water. Long Beach had been raised above high-water storm tides, so that the wash of sand into the improved channel inside the beach had been stopped.

A ruling depth of the approaches to Wareham had been increased from 7 to 9 feet, and the channel greatly widened in all the reaches.

Vessels of larger draught can be carried to Wareham than formerly. The increase in width of channel was a great help to all vessels in beating in and out of the harbor.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of dredging had been temporarily discontinued, as the contractor, who is also the contractor for the dredging at Hyannis Harbor, Massachusetts, desired to remove the plant to the latter place, which is considerably exposed to the sea, and utilize the summer months in dredging there. It was resumed October 23, 1887, and suspended December 3 on account of ice. The amount of material removed up to the end of the fiscal year was 10,680.2 cubic yards.

The contractor has failed to resume operations and the time for the completion of the contract expired on June 15.

Mr. Thomas A. Churbuck was local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year was $2,320.49. The eastern half of the second and third reaches below the wharves and about two-thirds of the eastern half of the fourth reach, which extends to Barney's Point, were deepened to 10 feet at mean low water. The channel for about one-half its width from Barney's Point to Wareham has been deepened to 10 feet.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the excavation of the channel to its full width and depth down to the deep water above

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Long Beach, and the further building up of Long Beach by the construction of sand fences.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to devote the remainder on hand July 1, 1888, to the completion of the channel for one-half its proposed width as far as the funds available will permit and to the building up of Long Beach.

Wareham is in the New Bedford collection district. New Bedford is the nearest port of entry. The amount of revenue collected at New Bedford in the last fiscal year was $58,865.60. The nearest light-houses are Bird's Island and Wing's Neck lights. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1887, amount available		$10,295.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,816.50	
July 1, 1888, outstanding liabilities	503.99	
July 1, 1888, amount covered by existing contracts	7,975.47	
		10,295.96
Amount appropriated by act of August 11, 1888		4,000.00
Amount (estimated) required for completion of existing project		12,236.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		12,236.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. G. C. Tobey, Wareham, Mass., 1887.]

Arrivals and departures of vessels annually	400
Merchandise received and shipped, tons	65,000

C 5.

IMPROVEMENT OF WESTPORT HARBOR, MASSACHUSETTS.

Westport Harbor is an estuary of a bay lying between Narragansett Bay, Rhode Island, and Buzzard's Bay, Massachusetts. The site of the work is on Horse Neck Point (the north side of the entrance to the harbor).

ORIGINAL CONDITION.

Before the commencement of the improvement the site of the present work was a point of sand forming the northern and eastern boundary of the entrance to the harbor, and subject to erosion by the sea and tides.

PLANS OF IMPROVEMENT.

The project for the improvement of Westport Harbor, approved by the Secretary of War February 23, 1887, is to construct wooden jetties, filled

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with stone, at the end of Horse Neck Point, to stop the wearing of this point; the number and spacing of the jetties to depend on the price at which the work is let.

OPERATIONS DURING THE LAST FISCAL YEAR.

The available funds were sufficient to construct but one jetty.

The work of the construction of the jetty on Horse Neck Point, which was commenced June 22, 1887, was completed July 28. Mr. David Hamilton was the local inspector of the work.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The completion of the jetty referred to above finished the work as far as projected.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

No work is proposed for the fiscal year ending June 30, 1889.

Westport Harbor is in the New Bedford collection district. New Bedford is the nearest port of entry. The amount of revenue collected at New Bedford in the last fiscal year was $58,865.60. The nearest light-house is West Island Light. The nearest fortification is the fort at Clark's Point, New Bedford, Mass.

Money statement.

July 1, 1887, amount available	$890.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	890.66

C 6.

IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

This river rises in Norfolk County, Mass., and empties into Mount Hope Bay, a name given to the northeastern part of Narragansett Bay. It is about 44 miles in length, measured along its course.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its extensive manufactures dependent largely on water transportation, so that vessels of 11 feet draught can reach the city at high water. The rise and fall of the tide before improvement was 5¼ feet at Dighton and 3.4 feet at Taunton.

ORIGINAL CONDITION.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

PLANS OF IMPROVEMENT.

The approved project of 1871 and its subsequent modifications provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to

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the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Brigg's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep. From Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

A plat of the river showing the improved channel was published in the Annual Report of the Chief of Engineers for 1884, page 606.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on the improvement of the river up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $153,618.35.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard on account of interfering with private property, and that on account of the hardness and depth of material at the sides the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge had been completed. The channel as proposed between Berkley Bridge and Dighton had been completed with the exception of a small amount of dredging and the removal of the bowlders. The channel had been cleared of bowlders from Taunton down to Berkley Bridge. The work of removal of the ledge at Peter's Point had been completed. The material blasted in the channel had been dredged and deposited in the form of a half-tide dam running from Reuben's Island to the west shore of the river, with the view of accelerating the current in the dredged channel off and above Dighton, and preventing deposits in this part of the channel.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year work was in progress under a contract with J. H. Fenner, of Jersey City, N. J., described in the Annual Report of 1885, for cutting a channel 12 feet deep and 100 feet wide through the ledge at Peter's Point, and excavating by dredging a channel of the same dimensions between the upper part of "The Nook" and Dighton.

The immediate locality of the work at the beginning of the fiscal year was between Peter's Point and Dighton, where the channel was completed August 6, 1887, with the exception of the removal of a small amount of ledge rock uncovered in dredging. The removal of the bowlders in the channel from the upper part of "The Nook" to Dighton was completed October 12.

Mr. L. F. Pendleton was local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $3,317.59.

The results were the completion of the channel as proposed between Berkley Bridge and Dighton, with the exception of a small amount of

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ledge rock uncovered in dredging below Peter's Point, leaving the channel above Berkley Bridge as at the beginning of the fiscal year as stated above. Vessels of 11 feet draught can now reach Taunton, at the head of navigation.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

There remains to complete the existing project the widening and deepening at a few points above the bridge, and the removal of a small amount of ledge rock uncovered in dredging below Peter's Point. This ledge projects about 30 feet into the eastern side of the channel, diminishing its depth by a few inches, while there is ample width and depth beyond the channel line on the western side.

In compliance with the provisions of the river and harbor act of August 5, 1886, a survey of portions of Taunton River, made in October, 1887, and the map and report thereon were submitted to the Chief of Engineers November 21, 1887, for which see Appendix.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

No work is contemplated for the fiscal year ending June 30, 1889.

Taunton is in the Fall River collection district. Fall River is the nearest port of entry. The amount of revenue collected at Fall River in the last fiscal year was $40,805.75. The nearest light-house is the Borden Flat light-house. The nearest fortification is Fort Adams, Newport Harbor, Rhode Island.

Money statement.

July 1, 1887, amount available	$3,381.65
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,317.59
July 1, 1888, balance available	64.06
Amount (estimated) required for completion of existing project	13,986.94
Amount that can be profitably expended in fiscal year ending June 30, 1890	13,986.94

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Messrs. Staples & Phillips, Taunton, Mass., 1885.]

Lumber	feet..	11,000,000	Metal of all kinds	tons..	39,000
Grain	bushels..	1,228,000	Cotton	bales..	25,500
Flour	barrels..	40,000	Molding sand	tons..	22,000
Coal	tons .	240,000	Clay	do...	28,000
All other kinds of merchandise	tons..	20,000			

C 7.

IMPROVEMENT OF WARREN RIVER, RHODE ISLAND.

Warren River is an arm of Narragansett Bay north of the harbor of Bristol. This is a new work, and no appropriation had been made for it until, by act approved August 5, 1886, Congress appropriated $5,000 for the improvement of the river. In his report, January 12, 1885, of the survey made in accordance with the act of July 5, 1884, Colonel

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Elliott stated that the obstructions to navigation were a rocky reef below Little Island and a submerged bowlder known as Bushworth Rock near mid-channel, opposite the lower wharf of the town of Warren, and recommended that this bowlder and the reef referred to be removed as far as it could be done with an expenditure of $5,000 for both purposes.

PLANS OF IMPROVEMENT.

The work of improvement is one that can not be well carried on by contract, and the approved project is first to remove Bushworth Rock, and afterwards to remove the bowlders which lie submerged on the western side of the narrowest portion of the channel at Little Island, and also the projecting portions of the ledge beneath the bowlders, widening the channel as much as the funds available will allow; it also includes the hiring in open market of a vessel with working crew, submarine diver, firing battery, and steam-hoisting apparatus, and purchase of the explosives also in open market.

A plat of the river showing the proposed improvement near Little Island, was published in the Annual Report of the Chief of Engineers for 1885, page 630.

OPERATIONS DURING THE LAST FISCAL YEAR.

The work of the removal of bowlders and ledge rock, under the approved project, was commenced August 1, and continued until November 23, when the limit of the appropriation was reached. During this time 811 tons of bowlders, ledge rock, and gravel, were removed and placed on the shore.

Mr. Theo. Topham was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $4,699.39. The result was the removal of Bushworth Rock to the depth of the surrounding water, and the removal of the bowlders and points of ledge rock over an area of about 1.8 acres, in the vicinity of Little Island, extending 550 feet along the narrowest part of the channel.

WORK REQUIRED TO BE DONE TO COMPLETE THE EXISTING PROJECT.

The work carried on from August to November, 1887, finished the improvement as far as projected:

Warren River is in the Bristol-Warren collection district, which is a port of entry. There was no revenue collected in the last fiscal year. The nearest light house is the light-house on Conimicut Point, Providence River. The nearest fortifications are fort on Dutch Island, and Fort Adams, R. I.

Money statement.

July 1, 1887, amount available	$4,969.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,699.39
July 1, 1888, balance available	270.11

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C 8.

IMPROVEMENT OF PAWTUCKET RIVER, RHODE ISLAND.

The navigable part of the Pawtucket (or Seekonk) River, an arm of Providence River, extends from Providence to Pawtucket, a city which has a population of about 23,000, and extensive manufactures, depending largely on water transportation. The object of the improvement is to widen and deepen the channel leading to Pawtucket, so that vessels of 12 feet draught can reach that city at mean low water. The mean rise and fall of the tide is about 5 feet.

ORIGINAL CONDITION.

Before improvement the channel in the river had a ruling depth of about 5 feet at mean low water.

PLANS OF IMPROVEMENT.

The original project, as modified in 1883, provides for the excavation by dredging of a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to the ledge opposite Grant & Company's Wharf at Pawtucket; thence the deepening by blasting of the channel through the ledge to Pawtucket Bridge to the same depth and 40 feet wide.

A plat of the river showing the lines of the proposed channel was published in the Annual Report of the Chief of Engineers for 1884, page 608.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended to June 30, 1887, was $110,969.70. The channel had been excavated under the original project to a width of 75 feet and a ruling depth of 7 feet at mean low water, and under the project as modified in 1883 a new channel 12 feet deep and 100 feet wide, with wide enlargements at the bends, had been carried from its mouth at the deep water just above Red Bridge, a distance of about 9,940 feet, or to a point about 2,200 feet above a line drawn from Bucklin Island to Swan Point Wharf.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of dredging under the project for the expenditure of the appropriation of $30,000 of August 5, 1886, approved by the Chief of Engineers, was in progress and was continued until October 6, when the limit of the appropriation was reached. This project contemplated the continuation of the enlarged channel as far towards Pawtucket as the funds would allow, affording at the same time such relief as the commerce may require at the shoalest places above the main work.

The amount of material dredged was 72,248.58 cubic yards. Capt. M. S. Persons was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $20,160.29, and the result is the excava-

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tion of the channel about 2,800 feet up the river. There is now a channel 100 feet wide and 12 feet deep at mean low water from the deep water above Red Bridge to Bass Rock, or to within about 1¼ miles of the head of navigation.

This completed portion of the channel is already a great benefit to the commerce of the river. A ruling depth of about 6 feet can be carried from the upper end of our present work to Pawtucket.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work yet to be done is to excavate, by dredging, the channel 12 feet deep and 100 feet wide, from Bass Rock to a point opposite Grant & Company's Wharf and thence to Pawtucket Bridge, to deepen the channel through the ledge to the same depth with a width of 40 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

Should an appropriation be made for this work it is proposed to extend the channel toward Pawtucket.

Pawtucket is in the collection district of Providence, and that port is the nearest port of entry. The amount of revenue collected at Providence in the last fiscal year was $240,197.75. The nearest light-house is Sassafras Point Light. The nearest fortifications are Fort Adams, Newport, R. I., and the fort on Dutch Island, Rhode Island.

Money statement.

July 1, 1887, amount available	$21,036.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	20,160.29
July 1, 1888, balance available	875.97
Amount appropriated by act of August 11, 1888	35,000.00
Amount available for fiscal year ending June 30, 1889	35,875.97
Amount (estimated) required for completion of existing project	367,478.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Furnished by Business Men's Association, Pawtucket, R. I.]

RECEIPTS.

Coal	tons	150,000
Cement	barrels	9,657
Lime	do	5,628
Long lumber (about)	feet	5,000,000
Short lumber	do	1,000,000
Spool wood	do	270,000

Together with large quantities of brick, iron, gravel, cotton, and various kinds of other merchandise which are used by this community.

There passed through the draw of the Washington Bridge, Pawtucket River, during the year 1887:

Steamers	684	Tow-boats	2,356
Schooners	334	Sail-boats	486
Barges	492	Miscellaneous craft	1,470

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C 9.

IMPROVEMENT OF PROVIDENCE RIVER AND NARRAGANSETT BAY, RHODE ISLAND.

Providence River is an estuary of Narragansett Bay. The object of its improvement is to furnish a wide and deep channel for European and coastwise commerce from the ocean to Providence, a city of about 125,000 inhabitants, largely engaged in manufactures, and a port of entry for an extensive region of country with which it is connected by railroads. The mean rise and fall of the tide is 4.7 feet.

ORIGINAL CONDITION.

Before the improvement of the river was commenced, in 1853, many shoals obstructed navigation, and at one point in the channel, a place called "The Crook," the available low-water depth was but 4½ feet.

PLANS OF IMPROVEMENT.

There was expended between 1852 and the 30th of June, 1882, $290,459.34 in deepening the channel; first to 9 feet, then to 12 feet, then to 14 feet, and again to 23 feet, as the increasing sizes of vessels and the growing commerce of Providence demanded. Bulkhead Rock was also removed during this period to a depth of 20 feet below mean low water.

The approved project of 1878, modified in 1882, under which we are now working, provides for a channel 25 feet deep and 300 feet wide suitable for large ocean vessels, extending from Fox Point, in the city of Providence, to the deep water of Narragansett Bay, and for an anchorage-basin between Fox and Fields points of the following dimensions in cross-section, viz:

300 feet wide, 25 feet deep.
600 feet wide, 20 feet deep.
725 feet wide, 18 feet deep.
940 feet wide, 12 feet deep.
1,060 feet wide, 6 feet deep.

The 25-foot channel has been laid out in straight reaches (with enlargements at the angles), with a view to lighting them by range or leading lights, such as are used in similar cases in Chesapeake Bay, Delaware River, and other localities, if it should be found necessary.

A plat of Providence River, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 622.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on the present project up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $222,836.68. At that date about one-half of the excavation required for the anchorage-basin above Field's Point had been done. Bulkhead Rock had been removed, and the 25-foot channel, 300 feet wide, from Providence to the deep water of Narragansett Bay, had been completed.

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OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the fiscal year the work of dredging, in that portion of the anchorage-area between Fox Point and Field's Point to be deepened to 20 feet at mean low water, was in progress and continued until October 12, when the contract was completed; up to this date 199,580 cubic yards of material had been dredged during the fiscal year.

Mr. W. C. Simmons was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $19,762.92. The result was the completion of the excavation of the 20-foot anchorage-area in the Fox Point Reach, and about one-fourth of the same area in the Sassafras Point Reach. The 25-foot channel, 300 feet wide, from Fox Point in the city of Providence to the deep water of Narragansett Bay, has been completed.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

There is required for the completion of the existing project the remainder of the excavation of the anchorage-basin between Fox and Field's points.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

Should an appropriation be made it is proposed to continue the excavation of the anchorage-area.

Providence River is in the collection district of Providence, which is a port of entry. The amount of revenue collected at Providence in the last fiscal year was $240,197.75. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are fort on Dutch Island and Fort Adams, R. I.

Money statement.

July 1, 1887, amount available	$20,763.95
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19,762.92
July 1, 1884, balance available	1,001.03
Amount appropriated by act of August 11, 1888	40,000.00
Amount available for fiscal year ending June 30, 1889	41,001.03
Amount (estimated) required for completion of existing project	165,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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COMMERCIAL STATISTICS.

[Furnished by Providence Board of Trade.]

RECEIPTS.

Articles.	Quantity.	Articles.	Quantity.
Lumber.....feet..	3,736,000	Shingles.....	3,132,000
Laths.....	7,974,000	Pickets.....	9,080
Piling.....pieces..	150	Wood.....cords..	3,021
Salt.....pounds..	7,350,749	Logwood.....tons..	4,082
Brimstone.....tons..	630	Potatoes.....bushels..	36,950
Starch.....casks..	738	Clapboards.....	5,400
Cliff stone.....tons..	1,050	Brandy.....gallons..	4,597
Champagne.....baskets..	328	Beer.....do....	919
Cotton.....bales..	200,607	Beef.....tons..	8,349
Wool.....do....	61,207	Flour.....barrels..	244,381
Do.....sacks..	39,516	Corn.....bushels..	1,614,291
Do.....pounds..	5,103,371	Oats.....do....	1,278,738
Coal.....tons..	887,424	Dry goods.....cases..	59,766
Iron and steel.....do....	26,308	Paper.....tons..	2,341
Lumber.....feet..	49,088,910	Chemicals.....packages..	71,666
Oil.....barrels..	155,844	Hardware.....tons..	2,438
Waste.....pounds.	11,039,881	Liquor.....barrels..	20,276

TONNAGE.

Vessels.	No.	Tonnage.
Sail.....	87	15,254.48
Steam.....	35	16,884.95

C 10.

REMOVAL OF GREEN JACKET SHOAL, PROVIDENCE RIVER, RHODE ISLAND.

Green Jacket Shoal is in that part of Providence River which constitutes the harbor of Providence.

It lies off the wharves on the south front of the city, and occupies a part of the harbor that is required for anchorage purposes.

ORIGINAL CONDITION.

That part of the harbor in which the shoal is located is about 2,000 feet long, by from 600 to 1,200 feet wide; and of this area the shoal, or rather that part of it which was included between the 15-foot curves, takes up about 18 acres. There were channels on either side of the shoal, between it and the harbor lines, having, the one on the north side a width of 300 feet and a depth of 20 feet, and the one on the south side a width varying from 50 to 100 feet and a depth of about 15 feet at mean low water. The water on the summit of the shoal was 1 foot deep.

PLANS OF IMPROVEMENT.

The general project is the removal of the entire shoal to a depth of 25 feet at mean low water, limiting the work by lines drawn 200 feet from the harbor lines.

A plat of Green Jacket Shoal, with report of survey, was published

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in the Annual Report of the Chief of Engineers for 1885, vol. 1, pages 598–602.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended, including outstanding liabilities to June 30, 1887, was $767.47. At the close of the last fiscal year the work of dredging had not commenced.

OPERATIONS DURING THE LAST FISCAL YEAR.

The work of dredging under the approved project was commenced July 11, and continued until November 5, when the contract was completed. Two hundred and six thousand four hundred and thirty-one cubic pards of material were excavated.

Mr. W. C. Simmons was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended, including outstanding liabilities, to June 30, 1888, was $24,388.13. The result was the excavation to a depth of 25 feet at mean low water of an area of about 9¼ acres, extending along the western side of the shoal, making an important addition to the anchorage facilities of the harbor. On a portion of this area the depth of water before the completion of the contract was from 3 to 4 feet.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

Should an appropriation be made for this work it is proposed to continue the removal of the shoal according to the general project.

Green Jacket Shoal is in the collection district of Providence, which is a port of entry. The amount of revenue collected at Providence during the last fiscal year was $240,197.75. The nearest light-houses are the six light-houses in Providence River. The nearest fortifications are fort on Dutch Island and Fort Adams, R. I.

COMMERCIAL STATISTICS.

For the commercial statistics, see report of the improvement of Providence River and Narragansett Bay, Rhode Island.

Money statement.

July 1, 1887, amount available	$25,482.53
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	24,388.13
July 1, 1888, balance available	1,094.40
Amount appropriated by act of August 11, 1888	28,000.00
Amount available for fiscal year ending June 30, 1889	29,094.40
Amount (estimated) required for completion of existing project	58,096.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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C 11.

IMPROVEMENT OF NEWPORT HARBOR, RHODE ISLAND.

This harbor is at the main entrance to Narragansett Bay. These waters during summer and winter constitute a harbor of refuge for our European and coastwise commerce quite equal in every respect to that of New York Harbor, and are even more accessible. The objects of the improvement are to widen and deepen the southern (the main) entrance to the harbor, and to enlarge its capacity for vessels seeking refuge in storms, by increasing the area and depth of the anchorage within it. The mean rise and fall of the tide is about 3¾ feet.

ORIGINAL CONDITION.

Before improvement the capacity of the inner harbor was limited by shoals, and it was not adequate to the number and size of vessels seeking it for refuge. The southern (the main) entrance was obstructed by a bar which stretched out from Goat Island, and the general business wharves of the city could not be reached at low tide by vessels drawing more than 8 feet.

PLANS OF IMPROVEMENT.

The original project and its modifications under which we are now working are substantially as follows:

Deepening the southern entrance to 15 feet at mean low water and widening it by dredging Goat Island Spit northward to a line drawn from the dolphin which marks the spit to clear the permanent dock at Fort Adams by 100 feet; the excavation of a channel 750 feet wide and 15 feet deep at mean low water around and to the eastward of this dolphin; excavating to 13 feet at mean low water the area included between the 13-foot curve on the west, a line drawn from the southwest corner of Perry Mill Wharf to Lime Rock on the south, the harbor line on the east, and a line drawn parallel to and 50 feet from the city wharf on the north; excavating to 10 feet at mean low water the area northwest of a line drawn from Lime Rock through the spindle, which is in the southeast part of the harbor; the excavation of a channel 10 feet deep at mean low water along and outside the harbor line south to a point opposite the gas company's wharf, and the construction of jetties on the western shore of Goat Island to arrest the drift of littoral sand and gravel into the southern entrance.

A plat of Newport Harbor, showing the plans of the work, was published in the Annual Report of the Chief of Engineers for 1885, vol. 1, page 604.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $107,563.87, with the following results:

Of the area to be dredged to 13 feet within the harbor, about nine-tenths had been completed, except at a few places in the northern part of the harbor, where the material was found too hard for the dredge in use at the time. The channel along and outside the harbor line south

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to a point opposite the gas company's wharf, and the 15-foot channel 750 feet wide around and to the eastward of the dolphin on Goat Island Spit, had been completed, with the exception of a strip along the western edge and to the north of the dolphin. The increase of width to be made between the 15-foot curves at the southern entrance, by dredging the spit south of Goat Island, had been completed. The berth for vessels at the Quartermaster's wharf at Fort Adams had been deepened to 10 feet at mean low water, and the littoral sand from the outside of Goat Island had been stopped from washing into the channel at the southern entrance of the harbor by the construction of a jetty on the west side of the island.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of dredging in the 13-foot anchorage area under the contract with the Hartford Dredging Company, described in the last Annual Report of the Chief of Engineers, was in progress and was completed July 8.

Mr. Theo. Topham was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $560.36, and the result was the completion of the excavation of about nine-tenths of the 13-foot anchorage area. Of the total area to be dredged within the harbor (about 90 acres) about two-thirds have been completed. The berths for vessels at the quartermaster's wharf at Fort Adams was deepened to 10 feet at mean low water, and the effectual stopping for the present of the supply of littoral sand and gravel from the outside of Goat Island into the southern entrance by the jetty on the southwest shore of the island. The southern entrance is completed for vessels of 15 feet draught.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the dredging of a narrow strip along the western edge of the 750-foot channel around and to the eastward of the dolphin on the Goat Island spit; the remainder of the excavation within the harbor of the anchorage area of 13 feet depth, and the excavation also within the harbor of the anchorage area of 10 feet depth; also the building of additional jetties outside of Goat Island whenever they may be required to arrest the drift of littoral sand and gravel into the harbor entrance.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

Should any appropriation be made for this work it is proposed to complete the 15-foot channel as projected and extend the anchorage area as far as possible to the east and south.

Newport is in the collection district of Newport and is a port of entry. The amount of revenue collected at Newport in the last fiscal year was $4,774.26. The nearest light-houses are Lime Rock and Newport (Goat Island) lights. The nearest fortification is Fort Adams, Newport, R. I.

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Money statement.

July 1, 1887, amount available	$638.16
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	560.36
July 1, 1888, balance available	77.80
Amount appropriated by act of August 11, 1888	12,000.00
Amount available for fiscal year ending June 30, 1889	12,077.80
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Furnished by Mr. J. H. Cossens, collector of customs, 1887.]

RECEIPTS OF MERCHANDISE.

Articles.	Quantity.	Articles.	Quantity.
Coal.....tons..	50,000	Cement .....barrels..	9,000
Shingles.....	5,000,000	Brick	5,000,000
Laths.....	8,500,000	Lumber.....feet..	12,500,000
Lime.....barrels..	13,000	Hay .....tons..	1,000
Potatoes .....bushels..	2,600	Grain .....bushels..	350,000

C 12.

HARBOR OF REFUGE AT BLOCK ISLAND, RHODE ISLAND.

This island is a part of the State of Rhode Island. It is 14 miles east of Montauk Point, the eastern end of Long Island, and its nearest point is about 10 miles from the mainland. Besides the wants of the mackerel-fishing fleet and the general coast navigation, the island is an important point on our shores for ocean navigation. It has a signal station connected by submarine telegraph with the mainland. Vessels are passing the island at all times and on all sides of it, and its position renders it of national importance. The object of the improvement is to furnish a harbor of refuge for vessels engaged in foreign and coastwise commerce. The mean rise and fall of the tide is about 3 feet.

ORIGINAL CONDITION.

Before the construction of the present harbor of refuge Block Island had no harbor which afforded protection for decked vessels. The only ones used were open boats, which, on the approach of storms, were hauled up on the beach by oxen. The largest of these boats were of about 10 tons burden.

PLANS OF THE WORKS.

The original project and its subsequent modifications provided for a harbor of refuge on the eastern side of the island, consisting of an inner harbor or basin for small vessels and an exterior harbor for large ones.

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The basin was to be about 250 by 300 feet in area, and inclosed with the exception of an opening 80 feet in width. The exterior harbor was to be formed by a riprap breakwater, which has been built. About 300 feet from the sea end of this breakwater, which is 1,900 feet long, a gap 200 feet long was left for the convenience of vessels. The present project contemplates the filling of this gap and the enlargement of the inner harbor. A plat of Block Island, showing the position of the harbor of refuge and a plan of the works, may be found in the Report of the Chief of Engineers for 1885, vol. 1, pages 612, 613.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The total expenditure up to June 30, 1887, including liabilities out standing at that date, was $325,024.17. The inner harbor and the main breakwater, built in prolongation of the eastern side of the inner harbor and extending 1,900 feet from the shore, were constructed in the years 1870 to 1879, inclusive. The utility of the work at once became apparent. In the stormy weather the inner harbor especially was filled with fishermen and coasters, and it soon became necessary to increase its depth from 7 feet, to which it had been dredged in the first instance, to 9 feet at mean low water. In 1883 a strong jetty was built out from the cliff to the eastward of the inner harbor, and a masonry wall was constructed on the inside of the crib-work, forming the eastern side of the inner harbor. The filling in the gap in the main breakwater was carried to the height of about 1½ feet above mean high water, and at the close of the work under the last contract about one-half of the total amount of stone required for the completion of this work had been delivered and placed in the gap. The sea, which formerly came into the outer harbor through the gap in the main breakwater in easterly storms, had been stopped by this partial filling. A contract for the commencement of the enlargement of the inner harbor and filling the gap in the main breakwater was made.

OPERATIONS DURING THE LAST FISCAL YEAR.

The work of the commencement of the enlargement of the inner harbor and filling the gap in the main breakwater, provided for in the appropriation of August 5, 1886, was commenced July 11, 1887, and continued until November 30, when it was suspended for the winter; it was resumed April 17, 1888, and continued to the end of the fiscal year. There were 4,258 tons of riprap granite placed in the gap of the main breakwater, which carried that portion of the work as far as the funds available would allow. The timber jetty filled with stone, to form the shore end of the west wall of the proposed enlarged harbor, was built from high water to low water of spring tides a distance of 138 feet, and a substantial enrockment placed at its outer end to protect it from the action of the sea until the west wall is built.

The work of the construction of the north wall of the inner harbor was commenced near the breakwater, from whence it will be carried to the westward as far as the available funds will permit. At the close of the fiscal year the work was still in progress. Mr. Frank I. Angell was the local inspector of the work.

In response to a resolution of the Senate of the United States, passed April 17, 1888, calling for an estimate of the cost of the removal of a shoal obstructing navigation at the entrance to the harbor of Block

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Island, the following report was submitted to the Chief of Engineers on May 4:

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., May 4, 1888.

SIR: Referring to the letter of the Chief of Engineers of April 18, 1888, inclosing a copy of a resolution of the Senate asking for an estimate of the cost of removing a sand-bar which has recently formed, obstructing navigation, at the entrance of the harbor at Block Island, I have the honor to report that a gradual shoaling along the western side of the breakwater has taken place for a number of years; this reaches its maximum width at the point where the north wall of the proposed enlarged harbor joins the main breakwater, and since the survey of 1884 the 9-foot curve has advanced to the westward about 70 feet, reducing the distance between the 9-foot curves in the harbor by that amount. This distance at that time was 445 feet.

At the entrance to the present basin the 6-foot curve has advanced slightly to the westward since 1884, and this shoaling may interfere somewhat with beating out of the basin, and the extension of the shoal to the westward of the breakwater renders the landing of the steamers of the Fall River and Providence Steam-boat Company at their wharf outside of the basin difficult and uncertain.

It is estimated that the removal of the whole shoal to a depth of 9 feet to a line 20 feet from the breakwater would cost $5,000.

The removal of that portion of it opposite the entrance to the basin and extending to the end of the Fall River and Providence Steam-boat Company's wharf would cost $1,000.

The inclosed tracing shows the relative positions of the 9 and 6-foot curves of 1884 and 1888.

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

The formation of this shoal is probably due in a great measure to the lowering of the top of the main breakwater, caused by its settlement. The sea, coming up the eastern side of the island, holds in suspension a large amount of sand, and, breaking over the top of the breakwater, deposits it in the harbor. Cross-sections of the breakwater will be taken with a view to estimating the cost of restoring its original section. When this is accomplished and the harbor inclosed on the western side by a riprap wall the accumulation of sand within the harbor can be checked.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $13,983.95. The result was the filling of the gap to within about one-seventh of the total estimated amount, the construction of the timber jetty filled with stone forming the shore end of the western wall of the proposed enlarged inner harbor, and the commencement of the construction of its north wall.

THE WHARF AT BLOCK ISLAND.

In his annual report for the year 1886 Colonel Elliot recommended that the Government wharf on the land side of the inner harbor of refuge at Block Island should be turned over to the town of New Shoreham, the corporate name of Block Island, and that the following provisions be attached to the item for Block Island in the next river and harbor bill:

Provided, That the wharf on the land side of the inner harbor may be turned over to the town of New Shoreham for the public use of said town; but no tolls or charges shall ever be exacted for the use of said wharf by public vessels of the United States, or freight carried in such vessels.

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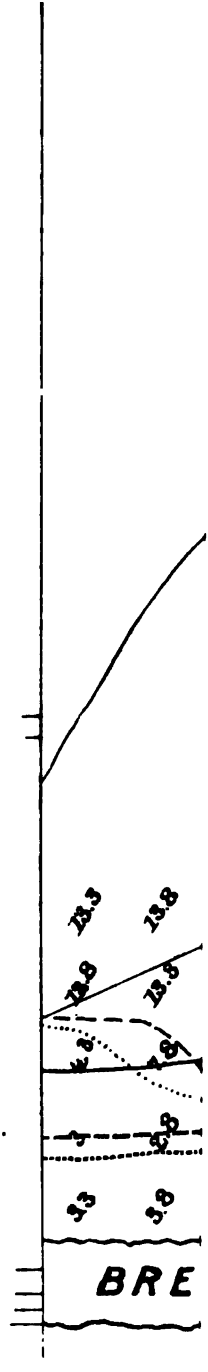

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And I would respectfully renew the recommendation.

The location of this wharf may be seen in the plat published at page 613 of the Annual Report of the Chief of Engineers for 1885.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the completion of the filling of the gap in the main breakwater, the restoring of the breakwater to its original dimensions, and the enlargement of the inner harbor.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to apply the amount available July 1, 1888, to the extension to the westward of the north wall of the inner harbor.

Block Island is in the Newport collection district, and Newport is the nearest port of entry. The revenue collected at Newport in the last fiscal year was $4,774.26. There is no duty collected at the island. The value of the harbor is mainly as a harbor of refuge. There are four lights at the island, the north and south lights and the breakwater lights. The nearest fortification is Fort Adams, Newport, R. I.

Money statement.

July 1, 1887, amount available		$19,975.83
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$10,049.21	
July 1, 1888, outstanding liabilities	3,934.74	
July 1, 1888, amount covered by existing contracts	5,215.09	
		19,199.04
July 1, 1888, balance available:		
Breakwater	197.31	
Inner harbor	579.48	
		776.79
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,776.79
Amount (estimated) required for completion of existing project		40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Hon. Nicholas Ball, Block Island.]

Report on the arrival and departure of steam and sail vessels, together with imports and exports, to and from Block Island for the year ending December 31, 1887:

Coal received (about)	tons	5,300
Iron received (about)	do	250
Grain received (about)	bushels	15,000
Lumber received (about)	feet	4,200,000
General merchandise, not included in the above, imported and exported, tons		15,000

ARRIVALS AND DEPARTURES FOR THE YEAR.

Steamers from 50 to 1,000 tons, drawing from 3 to 10 feet of water	2,100
Sailing vessels, from 10 to 200 tons, from 2 to 6 feet draught (about)	116,000

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C 13.

IMPROVEMENT OF LITTLE NARRAGANSETT BAY, RHODE ISLAND AND CONNECTICUT.

Little Narragansett Bay lies on the north side of the eastern entrance from the ocean into Long Island Sound; Pawcatuck River, upon which is situated the important commercial and manufacturing town of Westerly, R. I., empties into the eastern side of the bay, and has been improved by the United States. The object of the improvement of Little Narragansett Bay was to deepen the approach from Long Island Sound to Westerly.

The mean rise and fall of the tide is 2.63 feet.

ORIGINAL CONDITION.

The navigable draught of water through the bay before improvement was about 4½ feet at mean low water.

PLAN OF IMPROVEMENT.

The project of 1878 for the improvement of the bay provided for a channel 200 feet wide and 7½ feet deep at mean low water from the entrance to the bay to the mouth of the Pawcatuck, and the removal of the bowlders which then obstructed navigation, and any others which the excavation of the channel might develop. Subsequently it was determined to clear away some large bowlders which interfered with steam-boat navigation between this channel and Watch Hill Landing. The estimated cost of the improvement was $51,000.

A plat of Narragansett Bay, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1879, page 314.

AMOUNT EXPENDED AND RESULTS.

The project was completed in the fiscal year 1883–'84. The main channel as projected was excavated to its full width and depth, and many bowlders were removed from the Watch Hill Channel. Vessels drawing 10 feet of water can now reach the mouth of the Pawcatuck River at high water, but the full benefit of the improvement can not be utilized until further deepening of that river, which is now in progress, to enable vessels of the same draught to reach Westerly.

The remainder of the last appropriation for Little Narragansett Bay is reserved for comparative surveys of Sandy Point, at the entrance of the bay, which seems to be affected by the construction of the breakwater in Stonington Harbor, and for range-marks on Pawcatuck Point to guide through the new channel. The total cost of the completed improvement was $35,856.96.

Little Narragansett Bay is in the collection district of Providence and Stonington, the dividing line passing through the bay. Providence and Stonington are the nearest ports of entry. The revenue collected in the last fiscal year was: Providence, $240,197.75; Stonington, $1,659.18. The nearest light-houses are the Stonington and Watch Hill Lights. The nearest fortification is Fort Trumbull, New London, Conn.

Money statement.

July 1, 1887, amount available	$143.04
July 1, 1888, balance available	143.04

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C 14.

IMPROVEMENT OF PAWCATUCK RIVER, RHODE ISLAND AND CONNECTICUT.

The navigable part of Pawcatuck River extends from the manufacturing town of Westerly to Little Narragansett Bay, into which it empties. The approach to the river is though Stonington Outer Harbor and Little Narragansett Bay, and the object of the improvement is to deepen and widen the river channel leading from this bay to Westerly.

The mean rise and fall of the tide is 2.60 feet at the mouth of the river and 2.30 feet at Westerly.

ORIGINAL CONDITION.

Before improvement the channel was crooked and obstructed by numerous shoals, on some of which there was but 1½ feet at mean low water.

PLANS OF IMPROVEMENT.

By means of appropriations made in the years 1871–'75 the river was improved by the United States by the excavation of a channel 5½ feet deep at mean low water and 75 feet wide below the wharves and from 35 to 40 feet wide between the lower and upper wharves. The present project contemplates the widening of the channel to 100 feet below the wharves and by an additional width of two cuts of an ordinary dredging-machine, or about 40 feet, between the lower and the upper wharves; also the deepening of the entire channel to 8 feet at mean low water.

A plat of Pawcatuck River, showing the channel lines under the present project, was published in the Annual Report of the Chief of Engineers for 1885, part 1, pages 623–625.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended on the present project to June 30, 1887, including outstanding liabilities, was $3,535.12, and the result was the completion of the channel to its full width and depth from the deep water opposite the village of Lottery to Certain Draw Point.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the fiscal year the work of dredging under the project for the expenditure of the appropriation of August 5, 1886, which contemplated the beginning of the channel at the deep water opposite the village of Lottery and extending it as far towards Westerly as the funds would allow, was in progress and was continued until November 19, when it was suspended for the winter; it was resumed April 24 and continued until the close of the fiscal year, when it was still in progress.

During the fiscal year 48,938.8 cubic yards of sand and mud and 8.32 cubic yards of bowlders over 2 tons weight were excavated from the channel.

Mr. A. H. Dickens was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR AND RESULTS TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $6,928.50, and the result was the com-

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pletion of the channel to its full width and depth from the deep water opposite the village of Lottery to a point near the lower end of Major's Island, with the exception of a small amount of ledge rock which extends into the channel near Certain Draw Point and at Pawcatuck Rock.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is the dredging of the channel to a depth of 8 feet at mean low water, and width of 100 feet from the upper end of the present work to Westerly, and a width of 40 feet between the upper and lower wharves of that town; also the removal of the ledge rock near Certain Draw Point and Pawcatuck Rock.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to continue the work of widening and deepening the channel according to the new project as far toward Westerly as the funds will admit, and also to afford such relief as the commerce of the river may require at the shoalest places in advance of the main work, and to remove the points of ledge rock referred to above.

Pawcatuck River is in the collection districts of Providence and Stonington, the dividing line passing through the river. Providence and Stonington are the nearest ports of entry. The revenue collected in the last fiscal year was: Providence, $240,197.75; Stonington, $1,659.18. The nearest light-houses are the Stonington and Watch Hill lights. The nearest fortification is Fort Trumbull, New London, Conn.

Money statement.

July 1, 1887, amount available		$8,464.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$5,184.13	
July 1, 1888, outstanding liabilities	1,744.37	
July 1, 1888, amount covered by existing contracts	1,137.38	
		8,065.88
July 1, 1888, balance available		399.00
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,399.00
Amount (estimated) required for completion of existing project		16,637.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		16,637.00
Submitted in compliance with requirements of section, 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Messrs. Maxon & Co., Westerly, R. I.]

RECEIPTS AT WESTERLY BY WATER.

Coal	tons	18,540
Molding sand	do	547
Lumber	feet	5,309,790
Bricks		359,000
Grain	bushels	94,000

SHIPMENTS.

Stone	tons	2,350
Number of passengers carried by steamers		54,400

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C 15.

HARBOR OF REFUGE AT STONINGTON, CONNECTICUT.

Stonington Harbor lies on the north side of the eastern entrance from the ocean into Long Island Sound, and the main object of the improvement is to furnish a harbor of refuge for vessels entering and leaving this entrance to the sound. The mean rise and fall of the tide is about 2¾ feet.

ORIGINAL CONDITION.

Originally it was an open bay, unprotected from southerly storms and obstructed by a shoal, having a low-water depth of but 6 feet at the shoalest part. This shoal nearly filled the inner harbor and left but a narrow channel on either side of a depth insufficient to permit vessels of 12 feet draught to reach the upper wharves at low water.

PLANS OF THE WORK.

A short breakwater was constructed in the years 1828–'31 at a cost of $34,766.65 for the protection of the commerce of the town of Stonington. The enlarged project of 1871 for the improvement of Stonington Harbor and its subsequent modification, under which work is now carried on, embraced dredging in the upper harbor and the construction of two breakwaters in the outer harbor. One of these—the western—was to be built out from Wamphassuck Point, the southwestern limit of the harbor, and to extend about 2,000 feet, and the other—the eastern—was to extend from the vicinity of Bartlett's Reef to the Middle Ground. The western breakwater was completed in 1880 at a cost of $103,190. The amount expended in dredging in the upper harbor was about $45,000. The position of the western end of the eastern breakwater has not been determined, but it will probably be found necessary, in order to afford all the protection desired, to extend the breakwater at least until it intersects a range from Stonington Light to the middle of Wicopessit Island. It may then be found desirable to carry it still further, possibly to the range from Stonington Light to the eastern end of Fisher's Island.

A plat of this harbor, showing the position of the breakwaters, was published in the Annual Report of the Chief of Engineers for 1884, page 632.

AMOUNT EXPENDED AND RESULTS TO JUNE 30, 1887.

The amount expended upon the eastern breakwater up to the close of the fiscal year ending June 30, 1887, including liabilities outstanding at that date, was $105,115.19, and its length at that date was 2,150 feet.

OPERATIONS DURING THE LAST FISCAL YEAR.

At the beginning of the last fiscal year the work of extending the eastern breakwater to the westward, under the project for the expenditure of the appropriation of August 5, 1886, was in progress, and continued until October 27, 1887, when the limit of the appropriation was

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reached. During the fiscal year 3,550 tons of riprap stone were placed in the breakwater.

Mr. Charles C. Livermore was the local inspector of the work.

AMOUNT EXPENDED DURING THE LAST FISCAL YEAR, AND RESULTS, TO JUNE 30, 1888.

The amount expended during the last fiscal year, including liabilities outstanding June 30, 1888, was $4,433.71, and the result was the extension of the eastern breakwater to a point about 2,210 feet from its eastern extremity, or about .86 of the shorter of the alternative lengths projected.

WORK REQUIRED TO COMPLETE THE EXISTING PROJECT.

The work required to complete the existing project is to finish the construction of the eastern breakwater. In case it be found that sufficient protection to the harbor of refuge has been afforded when the range from Stonington Light to the middle of Wicopessit Island is reached, the length of the breakwater yet to be built is about 360 feet. Should it be decided to extend it to the middle ground it will require about 150 feet more.

By reason of the great danger to the large passenger steamers of the Stonington Line (New York and Boston), caused by the western end of the breakwater, especially in foggy and thick weather, and which will continue to exist until it is completed and a light-house and fog-signal are erected upon it, it is very desirable that the whole amount necessary to finish the breakwater should be included in one appropriation.

The completion of this work will afford a thoroughly protected anchorage for vessels drawing 18 feet of water, and a harbor of refuge for the commerce which daily passes between Long Island Sound and the the eastward.

OPERATIONS CONTEMPLATED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

Should an appropriation be made for this work, it is proposed to extend the eastern breakwater further to the westward.

Stonington Harbor is in the Stonington collection district, and is a port of entry. The amount of revenue collected at Stonington in the last fiscal year was $1,659.18. The principal value of the harbor is as a harbor of refuge. The nearest lights are Stonington Light and Latimer's Reef Light. The nearest fortification is Fort Trumbull, New London Harbor, Connecticut.

Money statement.

July 1, 1887, amount available	$4,884.51
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,433.71
July 1, 1888, balance available	450.80
Amount appropriated by act of August 11, 1888	8,000.00
Amount available for fiscal year ending June 30, 1889	8,450.80
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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COMMERCIAL STATISTICS.

[Furnished by Mr. H. G. Palmer, deputy collector.]

Number of vessels entered from foreign ports	10
Number of vessels cleared for foreign ports	10
Value of merchandise imported	$8,247.66
Amount of duties collected	$1,659.18
Estimated value of cargoes coastwise	$37,400,000.00
Estimated value of cargoes shipped coastwise	$35,000,000.00
Value of product of fisheries	$135,000.00
Number of vessels seeking harbor for refuge	2,400
Number of vessels registered in district	104
Tonnage	8,744.39

C 16.

PRELIMINARY EXAMINATION OF NEW BEDFORD HARBOR, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., November 26, 1886.

GENERAL: In compliance with the instructions contained in Department letter of the 28th October last, I have the honor to submit the following report of the preliminary examination of New Bedford Harbor, Massachusetts, provided for in the river and harbor act of Congress of August 5, 1886, and made by me on the 13th instant.

In the years 1875-'76 there was appropriated for the improvement of New Bedford Harbor the sum of $20,000, which was expended in excavating a channel 15 feet deep from the vicinity of the wharves to the deep water just above Palmer's Island.

Since that time the draught of the steamers plying between New Bedford and New York has increased, and I am informed that they not only now touch the bottom in this channel, but that in the channel below Palmer's Island, which was not included in the former improvement, there is not sufficient water at low tide for the commerce of the port.

New Bedford is an important port of entry. It is largely interested in manufactures and has an extensive commerce in addition to its whale fisheries.

In a petition from citizens of New Bedford, which was published in the Report of the Chief of Engineers for 1875, I find the statement that in the six months from April to October of 1874, 1,777 steamers, 56 ships, 13 brigs, 2,545 schooners, 1,025 sloops, in all, 5,416 vessels, passed Palmer's Island light-house in New Bedford Harbor, and that there were engaged in the whaling business 88 vessels requiring a depth of about 16 feet of water. I have no later information respecting the commerce of New Bedford, but it has doubtless largely increased, especially in respect of steamers.

I am inclined to the belief that the deepening of the channel desired can be done at comparatively small cost, and in view of the interests involved I am of the opinion that the harbor is worthy of further improvement.

I estimate the expense of the necessary surveys at $600, if authority to make them can be issued in time for completing them before Christ-

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mas, but if later the expense will be much increased by reason of delays by bad weather and ice.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF NEW BEDFORD HARBOR, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., October 17, 1887.

SIR: I have the honor to submit the following report on the survey of New Bedford Harbor, together with an estimate of the cost of its improvement.

This harbor is an estuary of Buzzard's Bay, forming the port of the cities of New Bedford and Fairhaven, Mass.

The survey was made on the 5th, 6th, and 7th of October.

Soundings were carefully taken from the deep water off Clark's Point to the wharves of New Bedford near the bridge. These soundings were reduced to mean low-water level, determined by observations for one month of tide-gauge at New Bedford. Borings were also taken throughout the entire length of the proposed channel to a depth of 20 feet at mean low water.

It will be seen from the accompanying sketch* that vessels drawing over 15 feet of water can not enter the harbor at mean low water.

It is proposed to excavate a channel 200 feet wide and 18 feet deep. The general position of this channel and of the areas to be excavated are shown on the sketch. The borings show that the material to be dredged consists of mud, sand, and gravel.

As it appears from the following estimate that the total cost of this channel will amount to less than $35,000, I have the honor to recommend that this amount, all of which can be profitably expended during the fiscal year ending June 30, 1889, be appropriated.

The lower part of the channel has been laid out in one straight reach, the axis of which passes through Palmer's Island light-house, so that vessels entering the harbor can run directly for it. The two upper reaches are so laid out as to involve the least amount of excavation.

In the years 1875–'76 there was appropriated for the improvement of New Bedford Harbor the sum of $20,000, which was expended in excavating a channel 15 feet deep from the vicinity of the wharves to the deep water just above Palmer's Island. Since that time the draught of the steamers plying between New Bedford and New York has increased, and vessels of 15 feet draught not only now touch the bottom in this channel, but in the channel below Palmer's Island, which was not included in the former improvement; there is not sufficient water at low tide for the commerce of the port.

Many vessels and barges of much greater draught than 15 feet are unable to carry their full cargoes.

New Bedford is adapted by its situation to become a commercial city of great importance. It was once the great center of the whaling

*Omitted. Printed in House Ex. Doc. No. 86, Fiftieth Congress, first session.

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industry in America, and is still one of the largest and most flourishing cities in New England, both in respect to its commerce and manufactures.

New Bedford is a port of entry. The amount of revenue collected at New Bedford for the fiscal year ending June 30, 1887, was $29,023.98.

ESTIMATE OF THE COST OF THE IMPROVEMENT.

One hundred and seventeen thousand cubic yards, measured in place, of material to be dredged and dumped south of Egg Island, at 27 cents	$31,590
Add 10 per cent. for contingencies	3,159
Total	34,749

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

COMMERCIAL STATISTICS, NEW BEDFORD, MASSACHUSETTS.

The harbor-master of New Bedford reports the arrival of eight sailing-vessels of over 100 tons burden per day throughout the year, 2,920, about 200 of which draw over 15 feet of water.

Mr. Charles W. Agard, agent of the Philadelphia and Reading Coal and Iron Company, reports vessels carrying coal, 180.

Old Colony Railroad and Steamboat Company's steamers make tri-weekly trips to New York.

New Bedford, Martha's Vineyard and Nantucket Steamboat Company make 600 trips annually with 5 steamers between the points named.

The following freight is reported as being received annually by vessels by the firms named.

Charles W. Agard, agent Philadelphia and Reading Coal and Iron Company, reports total coal received, 273,200 tons.

Charles S. Paisler and William A. Tillinghast report lumber received in 47 vessels of 160 tons, 8,000,000 feet.

William B. Fisher, agent for Old Colony Railroad and Steamboat Companies, report from New York line of steamers, cotton, over 35,000 bales; miscellaneous freight, 60,000 tons.

William F. Nye reports oil by schooners, 3,000 barrels; cases of bottled oil by steamers, 14,000.

Mr. Charles S. Kelley, vice-president of board of trade, states that New Bedford has inhabitants about 40,000; banking capital, $4,500,000; manufacturing capital (employed in 120 manufactories), $11,500,000; whalers of a tonnage of 28,291 tons, 75.

It is the third city in the United States in point of cotton manufactures.

C 17.

PRELIMINARY EXAMINATION OF TAUNTON RIVER, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., November 26, 1886.

GENERAL: In compliance with the instructions contained in Department letter of the 28th October last, I have the honor to submit the following report of the preliminary examination of Taunton River, Massachusetts, provided for in the river and harbor act of Congress of August 5, 1886, and made by me on the 19th instant.

Taunton River rises in Norfolk County, Mass., and empties into Mount

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Hope Bay, a name given to that part of Narragansett Bay which lies mainly in Massachusetts. It is 44 miles in length, measured along its course.

It has been improved by the United States under appropriations made in the years 1852–1884, amounting to $160,000.

The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quantities of coal, iron, clay, moldings, sand, and other heavy articles for its manufactures, depending largely on water transportation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth was not, in places, more than 5 feet at mean high water. A vessel of 30 tons burden was as large as could go up to Taunton.

The project under which the work is being carried on provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to, and through the Needles and Brigg's Shoal; thence to Berkley Bridge, a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water. The ledge which crosses the bottom of the river at Peter's Point and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton were to be removed.

A plat of the river, showing the improved channel, was published in the Annual Report of the Chief of Engineers for 1884, page 606.

With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard, on account of interfering with private property, and that, on account of the hardness and depth of the material at the sides, the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge has been completed.

The major part of the dredging below the bridge has been done, but this part of the channel still lacks in width at some places.

The last appropriation for this work, $26,500, made by the act of July 5, 1884, is not yet expended. The entire work from Berkley Bridge down, contemplated to be done, is now under contract, and the major part of it, including the excavation of a channel through the ledge at Peter's Point, to a depth of 12 feet at mean high water with a width of 100 feet, has been completed.

There remains to be done under this contract the completion of the deepening and widening of the channel below Berkley Bridge, by dredging. The work is to be paid for by the cubic yard, measured in scows, and just how much of the funds available will remain after the completion of the current contract can not now be stated with accuracy, but unless the filling in of the channel since our last survey, especially by the freshet of February, 1886, which broke the embankment of the Old Colony Railroad opposite Wikamount, and shoaled the water there, is greater than I anticipate, there will remain between $3,000 and $4,000 for additional work above the bridge.

The following is the work which the safe navigation of the river requires to be done above the bridge, and between it and Taunton:

(1) The removal of Pioneer Rock, a large bowlder estimated to contain from 60 to 70 tons.

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(2) The further deepening and widening of the channel at several points from just below Pioneer Rock to a point just below Three Mile River, especially at Brigg's Shoal.

(3) The cutting off of a sharp bend and enlargements of the channel at the mouth of Three Mile River.

(4) The enlargement of the channel at Burt's Turn and at the Fish Place.

(5) The removal of a deposit of sand in the channel at Weir, the head of navigation, caused by the freshet before referred to.

(6) The removal of a few other bowlders in and near the channel between Berkley Bridge and Weir.

My judgment is that the river is worthy of the further improvement above referred to, and that the remainder of the current appropriation that will be available at the completion of the present contract will suffice to pay for it, but this can not be determined until a survey is made, which I estimate will cost $300.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF TAUNTON RIVER, MASSACHUSETTS.

ENGINEER OFFICE, U. S. ARMY,
Newport, R. I., November 21, 1887.

SIR: I have the honor to submit the following report on the survey and further improvement of Taunton River, Massachusetts, together with map of survey just completed and estimate of the cost of improvement.

This river rises in Norfolk County, Mass., and empties into Mount Hope Bay, a name given to the northeast part of Narragansett Bay. It is 44 miles in length, measured along its course.

The survey was made between the 15th and 30th of October. Soundings were carefully taken over the areas mentioned in Colonel Elliot's report of the preliminary examination of the river.

These soundings are referred to mean high water, the plane of reference used on the Taunton River.

Borings were also taken over the areas surveyed.

The map* of the survey herewith submitted shows the areas over which the soundings and borings were taken, with the channel, as contemplated in the approved project, in a broken and dotted line, and the 11-foot contour in a broken line. On figure 4, at the head of navigation, the 10-foot contour is also shown in a dotted line.

The areas in which it is proposed to dredge are shaded, and are embraced between the 11-foot contour and the channel lines.

There is also on the same sheet, on a smaller scale, a map of the river from Weir to Somerset, on which the location of those portions of the river surveyed are indicated.

The river has been improved by the United States under appropriations made in the years 1852–1884 amounting to $160,000.

* Omitted. Printed in House Ex. Doc. No. 86, Fiftieth Congress, first session.

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The object of the improvement is to deepen and widen the channel leading to the city of Taunton, at the head of navigation, which requires large quanties of coal, iron, clay, molding-sand, and other heavy articles for its manufactures, depending largely on water transportation, so that vessels of 11 feet draught can reach the city at high water.

In its original condition the channel was narrow and obstructed by bowlders, and from Berkley Bridge to Taunton the depth in places was not more than 5 feet at high water. A vessel of 30 tons was as large as could go up to Taunton.

The project under which the work is being carried on provides for a channel 60 feet wide and 11 feet deep from Weir Bridge to the ship-yard; a channel 80 feet wide (100 feet at the bends) and 11 feet deep from the ship-yard down to and through the Needles and Brigg's Shoal; thence to Berkley Bridge a channel of the same width and 12 feet deep, and from Berkley Bridge to the deep water at Dighton the channel was to be 100 feet wide and 12 feet deep. The depths are estimated from high water.

The ledge which crosses the bottom of the river at Peter's Point, and the numerous bowlders which lay on the bottom and sides of the channel from Taunton to Dighton, were to be removed.

A plat of the river showing the improved channel was published in the Annual Report of the Chief of Engineers for 1884, page 606.

Colonel Elliot states in his report of the preliminary examination of this river November 26, 1886, as follows:

> With the exception that but 40 feet of the 60 feet of width could be dredged between the bridge at Weir and the ship-yard, on account of interfering with private property, and that, on account of the hardness and depth of the material at the sides, the 80-foot channel was not in all cases dredged to its full width, the channel down to Berkley Bridge has been completed.

During the past season a small amount of ledge rock above the plane of the bottom of the channel was uncovered by the dredging below Peter's Point. After the removal of this the channel below Berkley Bridge will be completed.

The object of the further improvement of the river is the widening of the 80-foot channel to its full dimensions where it is too narrow, the removal of the bowlders obstructing the channel between Berkley Bridge and Taunton, and the removal of the small amount of ledge rock in the channel below Peter's Point.

The areas in which it is proposed to dredge are shaded on the accompanying map, and are in the following localities:

(1) At the points indicated from just below Pioneer Rock to about 300 feet above the mouth of Three-Mile River.

(2) At Burt's Turn.

(3) At Pond Rock's Shoal.

(4) In the upper part of the channel at Weir Village.

(5) It is also proposed to remove the small amount of ledge rock uncovered in dredging between Peter's Point and Dighton, and to remove the bowlders in and near the channel between Berkley Bridge and Weir.

The estimated cost of completing the approved project is $14,051.

The channel as projected is shown on the map by a broken and dotted line. There is also shown, in the localities referred to above, a full line, indicating a channel 60 feet wide in the narrowest places and 90 feet wide at the bends, which it is estimated could be completed for $4,500.

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ESTIMATE FOR FURTHER IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

Dredging 12,534 cubic yards of material, including the removal of bowlders, at $1 per cubic yard	$12,534
Removing ledge below Peter's Point, six days of vessel and crew, at $40 per day	240
	12,774
Add 10 per cent. for contingencies, etc	1,277
Total	14,051

COMMERCIAL STATISTICS.

Receipts at Taunton, Mass., via Taunton River, for year ending March 1, 1887.

Articles.	Quantity.	Articles.	Quantity.
Flour.....barrels..	38.500	Iron.....tons..	31,000
Grain.....bushels..	1,300,000	Molding-sand.....do ..	22,000
Lumber.....feet..	8,700,000	Clay.....do ..	27,000
Coal.....tons..	228,000	Other merchandise.....do ..	23,000
Cotton.....bales..	26,000		

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX D.

IMPROVEMENT OF CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT, AND OF RIVERS AND HARBORS ON LONG ISLAND SOUND, CONNECTICUT AND NEW YORK.

REPORT OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS, BVT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Thames River, Connecticut.
2. New London Harbor, Connecticut.
3. Connecticut River, Massachusetts and Connecticut.
4. Clinton Harbor, Connecticut.
5. New Haven Harbor, Connecticut.
6. Breakwater at New Haven, Connecticut.
7. Milford Harbor, Connecticut.
8. Housatonic River, Connecticut.
9. Bridgeport Harbor, Connecticut.
10. Black Rock Harbor, Connecticut.
11. Southport Harbor, Connecticut.
12. Norwalk Harbor, Connecticut.
13. Stamford Harbor, Connecticut.
14. Port Chester Harbor, New York.
15. Mamaroneck Harbor, New York.
16. Echo Harbor, New Rochelle, New York.
17. New Rochelle Harbor, New York.
18. East Chester Creek, New York.
19. Greenport Harbor, New York.
20. Port Jefferson Harbor, New York.
21. Flushing Bay, New York.
22. Removing sunken vessels or craft obstructing or endangering navigation.

ENGINEER OFFICE, U. S. ARMY,
New York, July 9, 1888.

SIR: I have the honor to transmit herewith my annual reports upon river and harbor works in my charge for the fiscal year ending June 30, 1888.

For illustrations of these works I would respectfully refer to Annual Reports for 1885, 1886, and 1887.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D 1.

IMPROVEMENT OF THAMES RIVER, CONNECTICUT.

This river is formed by the confluence of the Yantic and Shetucket rivers at Norwich, Conn., and extends southward as a tidal stream 15 miles, to Long Island Sound. For 11 miles above its mouth the channel is from 13 to 80 feet deep, averaging over 30 feet for the first 4 miles.

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For 3 miles below Norwich the available depth in 1829 was but 6 feet at mean low water, where now there is over 10 feet. The work of improvement has been confined to a stretch of 3½ miles below Norwich. Histories of the improvements may be found in the Annual Reports of the Chief of Engineers, 1873, page 981, and 1879, Part I, page 331.

PROJECTS FOR IMPROVEMENT.

Prior to 1830 various attempts had been made by private parties or corporations to deepen the channel of this river near Norwich; the first ones were by excavation only, but subsequently stone piers were constructed perpendicular to the channel at shoal spots.

By act of March 2, 1829, $150 were appropriated "for making a survey of the river Thames with a view to improve the navigation of the same and the cost of such improvements."

The survey was made in 1829 by Capt. Hartman Bache, Corps of Engineers; at that time there were four old piers standing. In his report on the survey, dated February 20, 1830, and printed in House of Representatives War Department Document, No. 125, Twenty-first Congress, first session, Captain Bache submitted a project for making a channel 60 feet wide, to be either 12 or 14 feet deep at high water (9 or 11 feet at low water) by excavation, by rebuilding one of the existing piers, by adding to the other three wings extending up and down stream converting them into T-walls and by building ten new piers extending down-stream in curves. The piers were to be of riprap 3 feet wide on top, with side slopes of 45 degrees; they were to be built to heights of from 1½ to 3½ feet above highest tide, those farthest up-stream being the highest. The piers were estimated to require 43,436 cubic yards of riprap, and the excavation for a 12-foot channel was placed at 27,895 cubic yards, for a 14-foot channel at 69,251 cubic yards. The cost of whole work was estimated at $72,650. The project was adopted, and under appropriations of 1836, 1837, and 1838—$40,000 in all—the piers were built nearly as designed, with exception of two of the new piers and one wing-wall, which were not constructed; considerable dredging was done, but no complete record of amount appears to have been kept. At this time $500 were annually expended in river improvements by the Merchants' Bank of Norwich, Conn., being a bonus required by their charter. Work was stopped in 1839 by exhaustion of appropriations.

In 1866 a petition of citizens of Norwich, asking for an appropriation for removing obstructions in the river Thames, was referred to the Chief of Engineers and returned by him to the Secretary of War, with a report describing the work done upon the river, recommending no further work on the piers until their efficiency could be investigated satisfactorily, and stating:

> In conclusion it is considered that should the sum of $8,000 be appropriated for the improvement of this river, to be applied during the next fiscal year, all will be accomplished that can be justifiably undertaken until a commission decides upon other efficacious methods or systems of improvement.

June 23, 1866, an appropriation of $10,000 was made for improving the river, under which a survey was made and a project for dredging to obtain a depth of 11 feet at low water (14 feet at high water) was adopted. Under this and succeeding appropriations, up to 1878, this channel was dredged and as far as possible maintained with a width of 100 feet. March 3, 1879, $12,000 was appropriated "for the improvement of the Thames River to secure a 14-foot channel," and in accordance therewith the project was modified to provide for a channel of that depth. In 1882, upon recommendation of Major Barlow, approved by

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the Board of Engineers, the project was further modified by providing for the construction of five dikes or training-walls along the outer sides of the channel curves, with the addition of low walls on the inner sides should they be found necessary, the width of water-way between them increasing from 300 feet (about the full width of the river) at Thamesville, 1 mile below Norwich, to 480 feet at the lower dike.

The object of the training-walls was to utilize the effect of the tides in keeping the channel open; they were to be built up to high-water level, and to have an eggregate length of 13,800 feet. In the same year the projected channel was increased to 200 feet. The improvement was designed to extend over the first 3½ miles below Norwich, and the estimated cost was:

For the five dikes or training-walls	$82,800
For dredging 200 feet wide and 14 feet deep	125,280
Total	208,080

Under this project, up to July 1, 1887, the three dikes farthest downstream had been built, and a fourth one about one-third completed; 132,969 cubic yards of dredging had been done.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract with John A. Bouker, of New York City, for delivering riprap and building extension of the Rolling-Mill Dike, which was in progress at the close of the last fiscal year, was completed December 21, 1887. Since July 1, 1887, 6,542 tons of stone were delivered, building 1,513 linear feet of the dike, besides slight repairs on the three lower dikes. Under this contract, the total amount of stone delivered was 11,021 tons, and 1,883 linear feet of dike were built.

June 29, 1887, a contract was entered into with the Hartford Dredging Company, of Hartford, Conn., to dredge in the river at the rate of 12 cents per cubic yard. Work under this contract was begun July 18, 1887, and was completed October 6, 1887, channels 12 feet deep and 100 feet wide being made through the shoals just above and below the Thamesville Rolling-Mills; 37,953 cubic yards of sand and gravel were removed.

A letter from Hon. Charles Russell, M. C., to the Secretary of War, asking the "approximate cost of completing the 16 feet deep channel to Allyn's Point and the 14 feet deep channel to Norwich," was referred to the officer in charge for report, and the estimates asked for were submitted in May, 1888.

Proposals for dredging were received May 29, 1888, and a contract dated June 12, 1888, was entered into with the Hartford Dredging Company, of Hartford, Conn., at the rate of 19 cents per cubic yard. Work under this contract will be begun early in July, 1888.

PRESENT CONDITION OF THE IMPROVEMENT.

Of the five dikes provided for in the project, the three furthest downstream have been constructed at cost, as follows:

Location.	Date of completion.	Length.	No. of tons of riprap.	Cost, exclusive of supervision.
		Feet.		
Mohegan, 3¼ miles below Norwich	1883	2,988	Pile-dike.	$23,686.00
Trading Cove, 2¼ miles below Norwich	1882	2,370	17,207	21,113.05
Long Rock, 2 miles below Norwich	1885	2,800	11,945	12,781.15

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The next in order, the Rolling-Mill Dike, designed to be 4,350 feet long, was begun in 1885. Up to date, 3,093 feet of the south end of this dike have been built, leaving a gap of 390 feet at the "sand-pier," and extending to about 250 feet south of the lower Rolling-Mill embankment. These spaces are covered by old piers, which it is designed to dredge out and throw over into the line of the Rolling-Mill Dike. The project contemplated extending the Rolling-Mill Dike about 600 feet north of the lower Rolling-Mill embankment. Since its adoption the Lower Rolling-Mill Company has dredged a channel in towards shore on the north side of the embankment, which is now used as a landing. An opening of at least 100 feet ought to be left for this channel, and it probably will not be found expedient to continue the dike at all to the northward of the embankment. The upper dike, one-half mile below Norwich, to be 1,050 feet long, has not been begun.

The Trading Cove Dike has settled an average of about 1½ feet over its whole length, and the Mohegan Dike nearly a foot. Both ought to be built up to high-water level.

The channel is in nearly the same condition as at the time of the last annual report. Mean low-water depth on the shoalest places is about 10.5 feet. Pending the completion of the dikes only enough dredging has been done to maintain a navigable channel.

PROPOSED OPERATIONS.

Under the contract now in force the Middle Ground at Norwich will be dredged out as far as possible, and work will be done on the shoals where necessary to maintain a navigable channel of 11 to 12 feet depth at low water. With future appropriations it is proposed to complete the system of dikes and to dredge the channel 200 feet wide and 14 feet deep, as provided for in the project.

To the estimates of cost of the projected improvements, $4,000 per year should be added as necessary for maintenance of the channel.

Appropriations for the improvement of the Thames River have been made as follows:

Date.	Application.	Amount.
Mar. 3, 1821	Removal of obstructions placed during war of 1812	$150
Mar. 2, 1829	Survey	150
July 4, 1836	Piers and dredging	10,000
Mar. 3, 1837	....do	20,000
July 7, 1838	....do	10,000
June 23, 1866	Dredging and survey	10,000
Mar. 3, 1867	Dredging	72,000
Mar. 3, 1871	....do	15,000
June 10, 1872	....do	10,000
June 18, 1878	....do	10,000
Mar. 3, 1879	....do	12,000
June 14, 1880	....do	22,500
Mar. 3, 1881	Dredging and training-walls	30,000
Aug. 2, 1882	Training-walls	*35,000
July 5, 1884	....do	*25,000
Aug. 5, 1886	Training-walls and dredging	*22,500
	Total	$304,300

*Appropriated for present project: These with $20,000 from previous appropriation (see Annual Report for 1882, Part I, page 603), make total of $102,500 for present project.

The Thames River is in the collection district of New London. The nearest lighthouse is at the mouth of the river, on the west shore. Forts Trumbull and Griswold overlook the mouth of the river from either shore.

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Money statement.

July 1, 1887, amount available		$21,137.76
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,136.87	
July 1, 1888, amount covered by existing contracts	6,650,00	
		19,786.87
July 1, 1888, balance available		1,350.89
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		51,350.89
Amount (estimated) required for completion of existing project		79,600,00
Amount that can be profitable expended in fiscal year ending June 30,1890		79,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of contracts for improving Thames River, Connecticut, in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date.	Subject.	Price.	Remarks.
John A. Bonker, New York City ..	Oct. 23, 1886	Building riprap dike.	*$0.98	Completed December 21, 1887.
The Hartford Dredging Company, Hartford, Conn.	June 29, 1887	Dredging.	†0.12	Completed October 6, 1887.

*Per ton. †Per cubic yard.

Abstract of bids for dredging in Thames River, Connecticut, opened at Engineer Office, U. S. Army, New York City, May 29, 1888.

No.	Name and address of bidders.	Rate per cubic yard.
		Cents.
*1	The Hartford Dredging Company, Hartford, Conn	19
2	Morris F. Brainard, New York City	24
3	W. H. Beard, Brooklyn, N. Y	20

*Entered into contract June 12, 1888; work not yet begun.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

From the best obtainable estimates the amount of freight received at Norwich was 250,000 tons, valued at $3,250,000; rather more than half the tonnage is coal, the rest iron, lumber, and general merchandise. It is carried in vessels drawing 7 to 13 feet.

D 2.

IMPROVEMENT OF NEW LONDON HARBOR, CONNECTICUT.

New London Harbor is that part of the Thames River which lies in front of the city of New London, extending from Winthrop's Point to Long Island Sound, a distance of about 3 miles. It has good anchorage-ground and a channel from 30 to 50 feet deep and a quarter of a

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mile wide, extending up to Winthrop's Point. It is one of the best harbors on the Atlantic Coast. No improvements of general importance have ever been needed, and none were undertaken until 1880.

PROJECT FOR IMPROVEMENT.

In the annual report for 1878 upon the improvement of Thames River (see Annual Report of the Chief of Engineers for 1878, Part I, page 397), shortly after the completion of the New London Northern Railroad Wharf, a petition of certain citizens of New London and Norwich was presented, asking that the United States undertake the removal of a shoal east of that wharf. The desired work was estimated to cost $6,800, and it was recommended that it be included in the general project for the improvement of the Thames River. The estimate was as follows:

To remove the shoal and bowlders to a depth of 16 feet at mean low water will require the excavation of—	
125 cubic yards of bowlders, at $5 per yard	$625
37,000 cubic yards of gravel and mud, at 15 cents per cubic yard	5,550
Add for contingencies	625
	6,800

This shoal extended from the shore out about as far as the end of the wharf. The part whose removal was contemplated was that part lying south of a line running east from a point on the railroad wharf 500 feet from its outer end.

The river and harbor act approved June 14, 1880, appropriated "for the improvement of the Thames River, of which sum $2,500 shall be expended in the removal of rocks and sand from New London Harbor, $25,000." In 1881 and subsequently appropriations were made for improving New London Harbor.

The first work under this project, so inaugurated, was done in 1880. It was found that the presence of bowlders made the dredging much more expensive than had been counted on, and in the annual report for 1881 (see Annual Report of the Chief of Engineers for 1881, Part I, page 586) a new estimate was submitted, placing the cost from the beginning at $24,000.

In 1882 the project was modified so that the area to be dredged should be that part of the shoal lying southwest of a line running about southeast from a point on the wharf 600 feet from its outer end; the object of this modification was to avoid as far as possible the large bowlders that were found near the crest of the shoal and to keep the cost of the work within the last estimate, while affording no less accommodation to vessels using the wharf. The depth over this part of the shoal was from 5 to 15 feet at mean low water.

Nineteen thousand eight hundred dollars have been appropriated for this work; 22,902 cubic yards of sand and stones and 564 cubic yards of bowlders have been removed. The proportion of bowlders to mud and gravel in the original estimate was about 1 to 300; the proportion actually found has been about 1 to 41. The actual cost of dredging mud and gravel has averaged 54½ cents per cubic yard, and of removing bowlders $8.51 per cubic yard. The bowlders have ranged in size from one-fourth cubic yard to 5 cubic yards, many of them having to be blasted.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done, the project being substantially completed.

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Appropriations for improving New London Harbor have been made as follows, viz:

Date.	Application.	Amount.
June 14, 1880	Dredging shoal east of railroad wharf	*$2,500
Mar. 3, 1881	do	4,300
Aug. 2, 1882	do	9,000
July 5, 1884	do	2,000
Aug. 5, 1886	do	2,000
	Total	19,800

* Part of appropriation for Thames River improvement.

New London, the port of entry for the collection district of New London, is situated on the west bank of the Thames River, about 2½ miles from Long Island Sound; the harbor is the mouth of the Thames River.

New London light-house is located at the entrance to the harbor, on the west shore. Forts Trumbull and Griswold command the harbor from either side.

Money statement.

July 1, 1887, amount available	$204.33
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2.94
July 1, 1888, balance available	201.39

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR OF 1886.

The freight received on the east side of the New London Northern Railroad Wharf, the only landing benefited by the improvement, was 131,225 tons; shipped, 27,955 tons; total, 159,180 tons. It was carried as 359 cargoes in 9 steamers of aggregate registered tonnage of 7,887.05; the maximum draught of these steamers was 15 feet.

The general commerce of the harbor amounted to about 500,000 tons additional.

D 3.

IMPROVEMENT OF THE CONNECTICUT RIVER, MASSACHUSETTS AND CONNECTICUT.

This river rises in the northern part of New Hampshire, flows in a general southerly course between the States of New Hampshire and Vermont, crosses the States of Massachusetts and Connecticut, and empties into Long Island Sound at Saybrook Point, Conn. It is divided naturally into two parts, Hartford, Conn., at the head of navigation, being the point of division, and appropriations by Congress have generally specified in which part the money appropriated was to be expended.

The divisions are as follows:

1. *Above Hartford, Connecticut.*—Embracing a length of about 66 miles, from Hartford, Conn., to Miller's Falls, Mass.

2. *Below Hartford, Connecticut.*—Embracing a length of about 50 miles, from Hartford to Long Island Sound.

By the river and harbor act of 1882 an examination or survey of the Connecticut River, from Bellows Falls, Vt., to Pittsburgh, N. H., was authorized. Bellows Falls is about 105 miles above Hartford, and Pitts-

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burgh is 180 miles above Bellows Falls. A preliminary examination was made, the report on which, printed in the Annual Report of the Chief of Engineers for 1884, Part I, page 659, recommended no survey and proposed no plan of improvement.

(1) ABOVE HARTFORD, CONNECTICUT.

Miller's Falls, Mass., is at the head of possible navigation of the Connecticut River. From this point down to Holyoke, Mass., a distance of about 32 miles, the river is susceptible of improvement, but it can not be used by vessels now, on account of a dam and falls at Holyoke, which entirely obstruct navigation. The lockage required to lift boats from the lower to the upper levels at Holyoke is about 60 feet. From Holyoke, Mass., to Enfield Falls, Conn., a distance of 18 miles, there is a fair channel 4 to 5 feet deep at low water, which could be made 8 feet deep. Enfield Falls, or Rapids, cover a stretch of river about 5 miles long, having a fall of about 32 feet at low water. The bed is rocky and very uneven, and the slope is not uniform, but consists of a succession of long shallow reaches separated by rapids. From the foot of Enfield Falls to Hartford, a distance of 11 miles, the river has a broad sandy bed with a depth of 2 to 5 feet at low water. Under a charter from the State of Connecticut granted in May, 1824, the Connecticut River Company has constructed a canal with locks around Enfield Falls. The locks are 80 feet long, 18 feet wide, and 4½ feet deep. The canal is chiefly used for water-power; the company collects toll from vessels using it.

Following is a list of places in this part of the river where work has been done by the United States, with distances above the wagon-bridge at Hartford:

	Miles.		Miles.
Barber's Landing	4	Strong's Island	6½
Farmington River	5	Scantic River	7½

PROJECTS FOR IMPROVEMENT.

No general project for the improvement of this part of the river is on record as approved and adopted. All the work done has been under special projects for expenditure of the several appropriations. It consists of dredging at Barber's Landing in 1873, and construction of dikes or wing-dams at Scantic River, Strong's Island, and Farmington River in 1871, at Farmington River and Barber's Landing in 1878, and again in 1880 and 1881.

Plans and estimates for a larger canal around Enfield Falls were submitted in 1878 and modified in 1880 (see Annual Report of the Chief of Engineers for 1881, Part I, page 566). They proposed a canal on the east bank of the river, extending from above Enfield Falls down to the mouth of the Hockanum River, opposite and just below Hartford, as the best means of gaining an available depth of 8 feet from Hartford to and around the falls. The canal levels were to be 10 feet deep at low water and 120 feet wide at the water-line; the locks 200 feet long, 55 feet wide, with 8 feet depth over the miter-sills at low water. The cost of the work was estimated at $1,332,805. It was considered not advisable to begin construction with a less sum than $450,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done. The available money is insufficient to begin any general improvement in this part of the river.

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PRESENT CONDITION OF IMPROVEMENT.

The wing-dams are all in fair condition; they are as follows:

One at Scantic River, one at Strong's Island, one at the mouth of Farmington River, two nearly opposite the mouth of Farmington River, and two on the east bank opposite Barber's Landing.

The available channel depth from Hartford to Scantific River is about 2 feet at ordinary summer stage of water; this part of the river is navigable for freighting only when in freshet. No work has been done above Scantic River; the depth from there up to the foot of Enfield Falls is greater than from there down to Hartford.

PROPOSED OPERATIONS.

No work in the river above Hartford is contemplated during the ensuing year. Should any injury to the wing-dams occur, the money available will be sufficient for repairs.

Appropriations for improving the Connecticut River above Hartford have been made as follows, viz:

Date.	Application.	Amount.
July 11, 1870	Dams at Scantic River, Strong's Island, Farmington River, and Barber's Landing; repair of dams; dredging at Barber's Landing; surveys.	$20,000
March 3, 1871		20,000
June 10, 1872		25,000
March 3, 1873		20,000
June 14, 1880		15,000
	Total	100,000

Of these amounts the following balance is yet unexpended:

From appropriation of June 14, 1880, for "improving Connecticut River between Hartford and Holyoke" $9,133.20

Money statement.

July 1, 1887, amount available	$9,133.20
July 1, 1888, balance available	9,133.20

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Receipts by water.

Articles.	Tons.	Value.
Coal	4,000	$22,000
Paper and paper stock	300	12,000
Total	4,300	34,000

Vessels employed in this traffic.

Vessels.	No.	Tonnage.	Draught.
			Feet.
Steam-tugs	2	30	4
Scows	4	300	3½

In its present condition this part of the river is navigable only during freshets. The amount of freight in 1886 was unusually small, owing to the river current breaking through behind one of the dikes and leaving the main channel shoal; the dike has since been repaired.

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(2) BELOW HARTFORD, CONNECTICUT.

The Connecticut River below Hartford is a large stream, for the first 21 miles flowing in a winding course, mostly through alluvial meadows, which are overflowed at high water, and which consist of a light, sandy soil, easily undermined. For the remaining 29 miles to Long Island Sound, at Saybrook Point, the course is straighter, the banks more permanent and generally harder.

A gauge has been established at Hartford, whose zero is the lowest stage that the water is known to have reached from natural causes; closing the gates at the Holyoke Dam in time of drought has caused the water to fall lower. The usual low-water stage of the river in summer is about 1 foot on this gauge. Spring freshets ordinarily rise to 20 feet; the highest recorded stage of water is 29 feet.

The average tide at Saybrook is 3½ feet; at Hartford it is about 1 foot, though when the water stands above 5 feet on the Hartford gauge the tide there is not perceptible. The slope of the river from Hartford to Saybrook averages .0458 foot per mile. The bed of the river, through the alluvial meadows within 10 miles of Hartford, is constantly changing, from the undermining of the banks. It is said that in places it has changed its position a half mile. The bars in this part of the river, after being dredged, form again during freshets and ice-jams, so that some of them require dredging annually; others less frequently. This part of the river was worked upon by corporations and private parties at various times between 1800 and 1870. Several small stone piers, to deepen the channel at shoal places, were built in this way. Some of these are covered by new banks, the channel has shifted to the opposite side of others, and others still have been dredged out, because they had come to be obstructions. The depth sought by these works was 6 feet feet at low water.

The following list gives the names of the several places on the river below Hartford where work has been done by the United States, with their distances by course of channel below the Hartford Wagon Bridge:

Locality.	Miles.	Locality.	Miles.
Hartford Bar	1½	Pistol Point Bar	15
Clay Banks Bar	2½	Mouse Island Bar	20½
Pratt's Ferry or Naubuc Bar	5½	Haddam Island Bar	30
Press Barn Bar	6½	Cluster Rock	38
Glastenbury Bar	9½	Saybrook Bar (at mouth)	50
Dividend Bar	12		

PROJECTS FOR IMPROVEMENT.

By act of July 4, 1836, Congress appropriated $20,000 "for improveing the harbor at Saybrook, by removing the bar at the mouth of the Connecticut River." Under this appropriation a survey was made by Capt. W. H. Swift, U. S. Engineer Corps. In his report on this survey, dated January 31, 1837, and printed in House Ex. Doc. No. 252, Twenty-fifth Congress, Captain Swift submits a project for deepening the west channel over Saybrook Bar, dredging a cut 500 feet wide and 12 feet deep at mean low water, at an estimated cost of $54,380.50; the estimated cost per cubic yard for dredging and dumping was 25 cents. The available depth over the bar before dredging was 7 feet at mean low water. Captain Swift's project was approved, and work was begun

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in May, 1838, under contract with Randall, Haskell & Holmes, at the rate of 62½ cents per cubic yard, measured in scows; dredging was continued until the fall of 1840, when the appropriation was exhausted; 26,984 cubic yards of sand and stones had been removed, making a channel 1,500 feet long, 50 feet wide and from 11 to 12 feet deep. This channel was nearly destroyed by storms and freshets in the following winter and spring. March 1, 1843, $3,471.57 was appropriated to pay a balance due the contractors.

No further work was done upon the river until 1867. By act of Congress, approved March 2, 1867, a survey of the river was ordered, which was made in the following season, and which embraced all the principal bars and obstructions between Hartford and Long Island Sound. With the report on this survey, dated January 11, 1868, and printed on page 754 *et seq.* of the Annual Report of the Chief of Engineers for 1868, was presented a project for improving this part of the river; it proposed dredging at Hartford, Clay Banks, Pratt's Ferry, Glastenbury, and Pistol Point, to make channels 8 feet deep at low water and 100 feet wide, dredging at Saybrook Bar to make a channel 8½ feet deep and 200 feet wide, piling for shore protection at Hartford and Wethersfield, and the removal of Chester Rock, at a total estimated cost of $70,000; an estimate of $10,000 for annual maintenance was submitted. All the dredging done up to 1880 was in accordance with this project, estimated to make 9 to 9½ feet depth instead of 8 feet, and also to include Press Barn, Dividend, and Mouse Island bars; the piling at Hartford was built in 1871, and the removal of Chester Rock was begun in the same year, but abandoned by the contractor soon after beginning.

January 22, 1873, a project for building three jetties at Saybrook and for dredging was approved by the Secretary of War; the jetties were to be of a double row of piles 20 feet apart, filled with stone to a height of 8 feet above low water; the dredging was to be 9 feet deep and 400 feet wide; the estimated cost was—

Dredging	$17,850
Jetties	318,760
Total	336,610

Before work on the jetties was begun the plan of construction was modified to one for building them of riprap stone, triangular cross-section, rising to level of highest water *i. e.*, about 5 feet above mean low water, this plan being much more economical than the previous one.

The jetties were begun in 1873, and two of them were completed in 1881; the third has not been built and may not be needed; the west jetty has since been extended, and both have been repaired and strengthened.

In 1880 a project was adopted for permanent works of improvement at six of the worst bars (see Annual Report of the Chief of Engineers for 1880, Part I, page 396 *et. seq.*).

This project provided for riprap wing-dams, mattress shore-protection and rectification of the banks at the following places, viz:

Locality.	Amount.	Locality.	Amount.
Hartford Bar	$33,464	Glastonbury Bar	$114,922
Clay Banks Bar	69,116	Dividend Bar	7,110
Pratt's Ferry or Naubuc Bar	64,735		
Press Barn Bar	41,140	Total	330,487

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With dredging, to make and maintain a permanent channel. The project did not provide for extension and repair of the Saybrook jetties, nor did the estimate include any amount for annual dredging to maintain channels, nor for dredging between the jetties at Saybrook, nor for any work whatever at Pistol Point, Mouse Island, and Haddam Island bars, where dredging has since been required; all of these have consumed a large part of the appropriations made since. It is evident, therefore, that the contemplated works could not now be completed with the unappropriated balance of the estimate.

Under this project, extended as above, up to the close of the last fiscal year, a training-wall of riprap, 3,689 feet long, has been built at Hartford Bar (instead of the proposed wing-dam), and a riprap wing-dam, 5,300 feet long, had been built at Glastonbury Bar, both to the height of 3 feet above low water; part of the Hartford training-wall was subsequently built to 4 feet above low water; the west jetty at Saybrook had been extended to the 16-foot curve, the east jetty to the 12-foot curve, and a channel 120 feet wide and 12 feet deep at mean low water had been dredged between them, besides maintaining the required depth in the upper half of this part of the river by annual dredging at a cost of from $5,000 to $10,000 each year.

Since the project of 1880 was adopted, $161,250 have been appropriated for this part of the river, including $5,000 ordered by the appropriation act to be expended in Salmon River, a tributary 33 miles below Hartford. Of this amount only $40,715 have been applied to that part of the improvement provided for in the partial estimate of $330,487.

In a letter to the Chief of Engineers, dated December 21, 1887, it was recommended that "future operations be confined to completing the jetties at the mouth of the river to a height of 5 feet above high water and a top width of 6 feet; widening the channel between the jetties to 400 feet width with a depth of 12 feet at mean low water, and annual dredging to maintain the channel from Hartford to Long Island Sound," at an estimated cost as follows:

For completing jetties	$60,000
For dredging between jetties	20,000
	80,000
For average annual maintenance of channel from Hartford to Long Island Sound	10,000

The seasons for this change of project are fully given in the letter referred to, a copy of which is appended to this report. The recommendations made therein were approved by the Chief of Engineers, December 22, 1887.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract with James V. Luce, of Niantic, Conn., for building up the jetties at Saybrook, which was in progress at the time of the last Annual Report, was extended to August 31, 1887, and was completed August 27; 1,080 tons of granite were delivered in the west jetty after July 1, and during the previous fiscal year 6,289 tons had been placed in the east jetty and 540 tons in the west jetty, making a total of 7,909 tons delivered under the contract. The east jetty was built up to approximately 2 feet above high water and several weak places in the west jetty were repaired.

The contract with the Frank Pidgeon Dredging Company, of New York City, for dredging on the bars between Hartford and Haddam Island, which was in progress at the beginning of the fiscal year, was

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completed August 27, 1887, 26,254 cubic yards of sand having been dredged from the channels since July 1; the contract price was 11.7 cents per cubic yard. In September a small shoal had formed again in Hartford Bar, and with the approval of the Chief of Engineers this was dredged out in October by Mr. C. C. Goodrich, of Hartford, Conn., 5,220 cubic yards being removed, at the same price as the contract work preceding.

Following is a statement of the dredging done in the Connecticut River below Hartford during the calendar year of 1887:

Bar at—	By Hartford Dredging Company before June 30.	By Frank Pidgeon Dredging Company.		By C. C. Goodrich after June 30.	Total.
		Before June 30.	After June 30.		
Hartford	5,588	11,240	10,056	5,220	32,104
Clay Banks	.....	3,852	1,848	.....	5,700
Nanbuc	.....	.....	3,461	.....	3,461
Press Barn	.....	.....	2,449	.....	2,449
Glastonbury	.....	.....	5,079	.....	5,079
Dividend	.....	3,625	780	.....	4,405
Pistol Point	2,136	.....	2,581	.....	4,717
Total	7,724	18,717	26,254	5,220	57,915

In September, 1887, an examination of the river from Hartford to Dividend Bar was made, which showed that on the whole the condition of the bars is slightly better now than at the time of the last survey, 1879, and that since 1879 the erosion of the caving banks has averaged from 18 to 30 feet per year—about the same as the rate between 1867 and 1879.

February 4, 1888, Mr. C. C. Goodrich, of Hartford, Conn., submitted an offer for dredging in the river below Hartford during the season of 1888, at the rate of 10 cents per cubic yard for river work and for work on Saybrook Bar at a rate per day equal to the average per diem earning in the river. This offer, being lower than any contract prices ever obtained for the same work, was forwarded with recommendation to the Chief of Engineers, and approved by him February 15, 1888, the work to be done as an open market transaction, that method being most economical and advantageous to the Govrrnment. Work under this arrangement began June 13, and up to the close of the fiscal year the following amounts had been dredged:

	Cubic yards.
Clay Banks Bar	3,310
Hartford Bar	10,995
Glastonbury Bar	825
Total	15,130

Making channels of 9 feet depth through those bars. Work is still in progress at Hartford and Glastonbury.

The total amount of dredging done during the past fiscal year is 46,604 cubic yards.

PRESENT CONDITION OF IMPROVEMENT.

At the close of the fiscal year dredging upon the shoals formed during winter and spring had been begun. The spring freshets of 1888, though not unusually high, were of long duration, and left the bars with depths of 5 to 8 feet at low water. Under an arrangement now in force a channel 9 feet deep has been cut through Clay Banks Bar and partly through Hartford and Glastonbury bars.

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The channel between the Saybrook jetties, dredged in 1884, has shoaled about a foot at either end and has narrowed slightly.

The Hartford Dike is in good condition. It may be expedient in the future to build it higher, in order to increase the scour on the bar. The Glastonbury Dike, built on a convex bank, is now nearly covered by the advance of the bank.

Both jetties at Saybrook are in fair condition. They should be built up to the dimensions provided for in the project to make them permanent.

The lengths of the dikes and jetties are as follows:

	Feet.
Hartford Dike	3,968
Glastonbury Dike	5,300
Saybrook:	
West jetty	2,550
East jetty	2,316

PROPOSED OPERATIONS.

With the money now available, the channels which filled during the spring freshets will be dredged out, and if the funds are sufficient the channel between the Saybrook jetties will be widened.

The object of first importance in the improvement of this river is the maintenance of a depth of at least 9 feet at low water through such shoals as form in spring freshets, and so much of future appropriations as is necessary should be applied to this work. It is proposed to confine future operations to such annual dredging, to building up the jetties at Saybrook, and to dredging between them, in accordance with the approved project. The estimated cost of this work is:

Jetties and channel at Saybrook	$80,000
Annual maintenance of channels	10,000

Ninety thousand dollars can be profitably expended upon this work during the next fiscal year.

Appropriations for the improvement of the Connecticut River below Hartford have been made as follows:

Date.	Application.	Amount.
July 4, 1836	Dredging at Saybrook Bar	$20,000.00
Mar. 3, 1839	Dredging at Saybrook Bar (the unexpended balance of 1836 was re-appropriated).	
Mar. 1, 1843	Balance due contractors under previous appropriation	3,471.57
Mar. 2, 1867	Survey	3,995.22
July 11, 1870	Dredging at Pratt's Ferry, Pistol Point, Mouse Island; piling at Hartford.	20,000.00
Mar. 3, 1871	Dredging at Hartford, Clay Banks, Pier I, Pier J, Pratt's Ferry, Glastonbury, Pistol Point, and Chester Rock	35,000.00
June 10, 1872	Dredging at Pratt's Ferry and Pistol Point; Saybrook Jetty	40,000.00
Mar. 3, 1873	Dredging at Hartford, Pratt's Ferry, Glastonbury; Saybrook Jetty	20,000.00
June 23, 1874	Dredging at Hartford, Pratt's Ferry, Saybrook; Saybrook jetties	20,000.00
Mar. 3, 1875	Dredging at Hartford, Pratt's Ferry, Glastonbury; Saybrook jetties	20,000.00
Aug. 14, 1876	Dredging at Hartford, Pratt's Ferry, Glastonbury; Saybrook jetties; Salmon River dredging	20,000.00
1878	Compensation for previous dredging	4,203.00
June 18, 1878	Saybrook jetties; survey from Hartford to Rocky Hill	30,000.00
Mar. 3, 1879	Dredging at Hartford, Press Barn, Glastonbury	10,000.00
June 14, 1880	Dredging at Hartford and Glastonbury; Saybrook jetties	10,000.00
Mar. 3, 1881	Dredging at Hartford, Pratt's Ferry, Glastonbury; Glastonbury wing-dam and Saybrook jetties	30,000.00
Aug. 2, 1882	Dredging at Hartford, Clay Banks, Pratt's Ferry, Press Barn, Glastonbury, Dividend, Pistol Point, and Salmon River; Hartford Dike	45,000.00
July 5, 1884	Dredging at Hartford, Clay Banks, Pratt's Ferry, Press Barn, Glastonbury, Dividend, Pistol Point, Mouse Island, and between Saybrook jetties; extending west jetty at Saybrook	35,000.00
Aug. 5, 1886	Dredging at Hartford, Clay Banks, Naubuc, Press Barn, Glastonbury, Dividend, Pistol Point, and Haddam Island; repair of Hartford Dike and Saybrook jetties	26,250.00
Aug. 5, 1887	Compensation for previous dredging	4,745.43
	Total	397,665.22

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The Connecticut River is in the collection district of Hartford. By course of river, the distance from Holyoke, Mass., to Hartford, Conn., is about 34 miles, and from Hartford to Long Island Sound about 50 miles. There is a light-house on Saybrook Point, on the west shore of the river at its mouth, and another at the end of the west jetty, besides which there are three small beacon lights in the lower part of the river which are maintained by the United States.

Fort Trumbull, New London Harbor, Connecticut, about 16 miles east from Saybrook Point, is the nearest work of defense.

Money statement.

July 1, 1887, amount available		$21,222.80
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,311.76	
July 1, 1888, outstanding liabilities	1,679.67	
July 1, 1888, amount covered by existing contracts	8,487.00	
		17,478.43
July 1, 1888, balance available		3,744.37
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		13,744.37
Amount (estimated) required for completion of existing project		80,000.00
Amount required for annual maintenance of channels		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		90,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstracts of contracts for improving the Connecticut River, in force during the fiscal year ending June 30, 1888.

Name and address of contractors.	Date.	Subject.	Price.	Remarks.
James V. Luce, Niantic, Conn.	Oct. 27, 1886.	Increasing height of Saybrook jetties with rip-rap granite.	*$1.14	Contract completed under extension, August 27, 1887.
The Frank Pidgeon Dredging Company, New York City.	Apr. 23, 1887.	Dredging between Hartford and Haddam Island.	† 11 7/10	Contract completed August 27, 1887.

* Per ton. † Per cubic yard.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR OF 1886.

Receipts and shipments.

	Tons.	Value.
Coal	275,000	$1,375,000
Stone	365,000	2,337,000
Miscellaneous	355,214	60,827,740
Total	995,214	64,539,740

Vessels employed in above traffic.

[Draught, 6 to 11 feet.]

	Number.	Tonnage.
Owned in district:		
Steamers	18	3,887
Sail vessels	56	6,068
Barges	21	4,133
Not owned in district: Vessels of all kinds	95	14,088
Total	190	28,176

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LETTER OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
New York, December 21, 1887.

SIR: In my last annual report on the improvement of the Connecticut River below Hartford I state that—

It seems evident from experience that the completion of the works proposed in 1880 for the improvement of the river from Hartford to Middletown will not obviate the necessity for annual dredging, and it is not therefore considered advisable to continue that project, except perhaps by shore protection, which may reduce the amount of dredging needed. It is proposed to confine future operations to annual dredging, strengthening the jetties at the mouth of the river, and shore protection between Hartford and Middletown. An estimate for completing the jetties and shore protection will be submitted as soon as practicable. Until that is done the estimate for completion of existing project will be the same as in the last annual report.

In 1867 a survey of the Connecticut River below Hartford was made by Mr. Theo. G. Ellis, civil engineer, under my direction, and I submitted a report on this survey, dated January 11, 1868. (Annual Report of the Chief of Engineers for 1868, page 754.)

This report contained an estimate of $70,000 for improving the river between Hartford and Middletown, and including $9,000 for deepening the bar at the mouth of the river. This was principally for dredging and removing obstructions. An estimate of $10,000 for annual maintenance was also submitted. The results of work done in the river between Hartford and Middletown since work was commenced, in 1871, confirm the views I expressed in my report, that the most satisfactory and economical method of maintaining the channel in this part of the river is by periodical dredging.

There has actually been expended in dredging between Hartford and Middletown from 1871 to 1887, including $2,606.80 expended by private parties—

In 1871	$23,588.59
For the sixteen years following	93,407.50
Total	116,996.09

The average annual expenditure since 1871 being $5,838.

In 1878 and 1879 a survey was made, under direction of General G. K. Warren, of the river from Hartford to Rocky Hill, with a view of planning a system of *permanent* improvement. The system proposed (Annual Report of the Chief of Engineers for 1880, page 396) consisted of bank protection and wing-dams at an estimated cost of $330,487, as follows:

Hartford Bar	$33,464	Glastonbury Bar	114,922
Clay Banks Bar	69,116	Dividend Bar	7,110
Pratt's Ferry (or Naubuc) Bar	64,735		
Press Barn Bar	41,140	Total	330,487

No dredging is included.

The only work done under this project is a wing-dam at Glastonbury near the convex bank, 4,950 feet in length, at a cost of $11,374.60, and a dike at Hartford near the concave bank, 3,698 feet long, at a cost of $27,018.20. The location of these works is shown in sketch, page 636, Annual Report of the Chief of Engineers for 1885. The project at Glastonbury contemplated in addition protection on the opposite bank, without which no benefit could be expected, but at Hartford the project has been completed and extended, and the work appears to be as well located as possible to produce the effects anticipated. It is near the concave bank, and the channel is close to it. Favorable results are to

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be expected here, if at any point. This work was commenced in the fall of 1882 and completed in 1883 to 3 feet above low water; it was raised to 4 feet above low water for about two-thirds of its length in 1886.

The annual quantity and cost of dredging in the past four years at this locality has been as follows:

	Number of cubic yards dredged.	Cost.
1884	30,028	$3,002.80
1885	17,742	1,774.20
1886	22,225	2,222.50
1887	32,104	3,756.17
Average per annum	.....	2,688.92

The annual average amount and cost of dredging actually done at this locality for eleven years previous to 1884 was as follows:

Average annual amount	cubic yards..	8,248
Average annual cost		$1,515.28

While this increased amount is not caused by the dike, the result shows that a large amount of dredging is still necessary every year to meet the requirements of navigation. Similar results are to be expected at the other points when wing-dams and shore protections have been designed.

During 1887 dredging was done three different times at Hartford, owing to frequent freshets.

I feel satisfied that no system of permanent improvements can be constructed at a reasonable cost which would entirely obviate the necessity of annual dredging or reduce the amount sufficiently to warrant the expenditure. The reasons for this may be found in the following facts:

The portion of the river under consideration winds through bottom lands from Hartford to Rocky Hill, a distance of 11 miles by river and $7\frac{3}{8}$ miles in a straight line. The bed is continually changing by erosion of the concave banks and accretions on the convex banks. The extreme variation in the water level at Hartford is about 30 feet, with corresponding variation in discharge from 5,000 cubic feet per second to 211,000 cubic feet per second. The water falls rapidly after freshets, and the low water discharge is not sufficient to cut out such a channel as is needed for purposes of navigation. At present prices for dredging the channel can be maintained at a moderate cost.

I would therefore recommend that future operations be confined to completing the jetties at the mouth of the river to a height of 5 feet above high water and a top width of 6 feet; widening the channel between the jetties to 400 feet, with a depth of 12 feet at mean low water, and annual dredging to maintain the channel from Hartford to Long Island Sound.

The channel between the jetties was excavated in 1884 and 1885 to a depth of 12 feet below mean low water for a width of 120 feet, increasing the navigable depth about 5 feet. A slight shoaling has since occurred.

The amount required for this work is estimated as follows:

Completing jetties	$60,000
Dredging channel between them	20,000
Total	80,000

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Average annual amount for maintenance of channel from Hartford to Long Island Sound, $10,000.

Should these recommendations be approved, it is proposed to modify the project accordingly.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 22, 1887.

Respectfully returned, approved.

After such record as may be necessary has been made this paper will be returned to this office.

By command of Brigadier-General Duane.

JAS. C. POST,
Major of Engineers.

[Second indorsement.]

ENGINEER OFFICE, U. S. ARMY,
New York, December 27, 1887.

Respectfully returned to the Chief of Engineers, the necessary record having been made.

D. C. HOUSTON,
Lieut. Col. of Engineers.

D 4.

IMPROVEMENT OF CLINTON HARBOR, CONNECTICUT.

Clinton Harbor is on the north shore of Long Island Sound, about 10 miles west of the mouth of the Connecticut River. It consists of an open, shallow bay, and of the mouth of the Hammonasset River, a small stream which flows easterly in front of the town wharves and empties into the bay. For three-fourths of a mile above its mouth the river is separated from the bay by a narrow strip of sand and marsh. About 1840 a breach was made through this strip a half mile above the mouth of the river, which diverted a considerable part of the tidal flow, and since then two shoals have formed, one just inside the river's mouth, with 4.5 feet of water, and one out in the bay, shortly before reaching deep water in the sound, with a depth of 4 feet. It is said that formerly there were depths of from 8 to 12 feet on both these bars, and that shoaling occurred soon after the breach was made.

PROJECT FOR IMPROVEMENT.

By act approved March 3, 1881, Congress authorized a survey of the harbor, which was made the same year. In his report on the survey,

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dated January 17, 1882, and printed in the Annual Report of the Chief of Engineers for 1882, Part I, page 630, Colonel Barlow, U. S. Engineers, submitted a project for restoring the original condition of the channel by closing the breach, and by subsequently, should the increased tidal current not produce the deepening desired, dredging through the shoals, making a channel 100 feet wide and 6 feet deep at mean low water.

The cost of a dike to close the breach was estimated at $3,000, and the cost of the whole project, including the dredging, at $10,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Nothing was done; the available funds were not sufficient for continuing the improvement.

PRESENT CONDITION OF IMPROVEMENT.

The dike was built in 1883, using 1,574 tons of riprap granite, and costing, exclusive of superintendence, $2,219.34. An examination made in 1885 showed that it had settled about 2 feet and would require 500 tons of stone to build it up to full height; also that no material change in the channel had taken place since the dike was built. It seems established that the increase of tidal flow will not of itself deepen the channel as desired.

PROPOSED OPERATIONS.

It is proposed to complete the project by dredging channels 100 feet wide and 6 feet deep at mean low water through the two shoals in the harbor when the estimated funds, $7,000, are appropriated.

The only appropriation made for improvement of this harbor is the one of $3,000 in 1882, expended in construction of the dike.

Clinton Harbor is in the collection district of Hartford. The nearest light-house is in Falkner's Island, 8 miles southwest. Fort Hale, New Haven Harbor, 22 miles west, is the nearest work of defense.

Money statement.

July 1, 1887, amount available	$252.73
July 1, 1888, balance available	252.73
Amount (estimated) required for completion of existing project	7,000
Amount that can be profitably expended in fiscal year ending June 30, 1890	7,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Arrivals and departures of vessels		90 to 100
Shipments:		
Wood and lumber	tons	2,000
Hay and straw	do	500
Total	do	2,500
Receipts:		
Coal	tons	1,200
Lumber	M feet	108
Oysters	bushels	10,000
Draught of vessels using the harbor	feet	4½ to 7½
Tonnage of vessels using the harbor	tons	30 to 150

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D 5.

IMPROVEMENT OF NEW HAVEN HARBOR, CONNECTICUT.

New Haven Harbor is a bay on the north shore of Long Island Sound, extending about 4 miles inland and from 1 to 2 miles wide. The Mill and Quinnipiac rivers empty into the head of the harbor; these rivers are of no commercial importance except for tidal navigation at and near their mouths. The harbor channel is from 400 feet to a mile wide, with mud and sand flats on either side. When the Government began work in this harbor in 1867, the available low-water depth above Crane's Bar, about a third way down the harbor, was 9 feet; thence to Fort Hale, which is about half way down, it was 16 feet or over; a short distance below Fort Hale was a bar of very soft mud extending across the harbor, with 13 feet available depth at mean low water. The entrance to the harbor was partly obstructed by several sunken rocks.

PROJECTS FOR IMPROVEMENT.

Several plans for removal of certain of the rocks at the harbor entrance have been proposed and undertaken, but not completed. The removal of the harbor light-house to southwest ledge and the completion of the present plan for breakwaters will obviate the necessity for further work upon these rocks.

The work of deepening the channel in this harbor has for the most part been done in accordance with plans presented in annual or special reports to the Chief of Engineers, the projects being adopted to comply with subsequent appropriations and not based upon examinations or surveys ordered by Congress.

In a letter dated January 20, 1871, printed as House Ex. Doc. No. 95, Forty-first Congress, third session, and also on page 771 of the Annual Report of the Chief of Engineers for 1871, General Warren says that "the business of New Haven requires that there should be a channel dredged 200 feet wide and to a depth of 14 feet at mean low water up to the wharves," and that this is "in many respects more important to New Haven than the removal of the rocks at the entrance to the harbor." It was estimated to cost $64,815. March 3, 1871, $40,000 was appropriated and expended in the same year in making a channel 13 feet deep, 200 feet wide up to Long Wharf, 350 feet wide at the bend at Long Wharf, and 100 feet wide from there to the Steam-boat Wharf.

In a letter of December 23, 1871, printed in House Ex. Doc. No. 137, Forty-second Congress, first session, General Warren submitted an estimate of $26,250 for dredging 16 feet deep and 200 feet wide across Fort Hale Bar, adding that there was some doubt as to the permanence of such a channel. June 10, 1872, $15,000 was appropriated for the removal of rocks, and $20,000 for harbor improvement; the former amount was expended upon Luddington rock; the latter, with part of an appropriation of $25,000 made March 3, 1873, was expended in dredging on the Fort Hale Bar, and at the close of the season of 1873 the channel had been made 16 feet deep and 200 feet wide, as proposed; it soon filled to nearly its former condition. The 13-foot channel above Long Wharf was also widened to 110 feet.

In the Annual Report for 1873, General Warren says:

> It is thought that no improvement here beyond what can be accomplished with the funds now available is called for on the part of the United States and no further appropriation is asked for.

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No appropriation for this harbor was made in 1874, and none was recommended in the Annual Report for that year.

In a report dated January 27, 1875, in reply to the first part of a resolution of the House of Representatives, January 21, 1875, asking "for a report from surveys already made, in regard to the expediency of widening and deepening the main channel of New Haven Harbor, Connecticut, to a depth not exceeding 20 feet, and also the expediency and estimate of cost of a breakwater," * * * Colonel Barlow, United States Engineers, then in charge, presented estimates (see Annual Report for 1875, Part II, page 250):

For channel 400 feet wide and 20 feet deep	$416,490
For channel 400 feet wide and 18 feet deep	276,990
For channel 300 feet wide and 20 feet deep	329,925
For channel 300 feet wide and 18 feet deep	208,890

Also, February 8, 1875, in reply to request from the Chief of Engineers, he estimated $10,000 as the cost of widening to 200 feet the 13-foot channel above Long Wharf, already 110 feet wide. In submitting these reports the Chief of Engineers recommended the latter work "as being of immediate importance, and whatever action may be taken upon the project of making a 20-foot channel, this at least should be done." In a subsequent report on the same matter, February 9, 1875, Colonel Barlow presents an estimate of $35,000 for widening the channel above Long Wharf to 400 feet; this was transmitted to the House of Representives by the Secretary of War, February 13, 1875, with favorable indorsement of the Chief of Engineers. This latter plan was carried out under the appropriation of $10,000 made March 3, 1875, with a balance of about $6,000 from previous appropriations, and the 13-foot channel was made 415 feet wide above Long Wharf, the price of work being much lower than had been estimated.

Nothing was appropriated for this harbor in 1876 or 1877.

In the Annual Report for 1877, Colonel Barlow refers to the estimates submitted in letter of January 25, 1875, and recommends that the channel below Long Wharf be made 400 feet wide and 16 feet deep, its then dimensions, 200 feet wide and 13 feet deep, not affording "sufficient space for convenient navigation;" the estimated cost was $40,000. In 1878, under an appropriation of $25,000, made June 14, 1878, the channel was dredged to length and depth as proposed, with width of 300 feet.

In a letter, February 4, 1879, transmitting map of harbor examination made in December, 1878 (letter printed in Annual Report of the Chief of Engineers for 1879, Part I, page 336), Colonel Barlow recommends deepening the channel above Long Wharf and widening that below, to secure 400 feet width with 16 feet depth from the Steam-boat Wharf down to Fort Hale; also dredging a channel 500 feet wide and 16 feet deep through Fort Hale Bar; the work above Fort Hale was estimated to cost $65,000, that below $35,000. The proposed depth and slightly greater width above Fort Hale were obtained by October, 1881, under three successive appropriations of $15,000 each, in 1879, 1880, and 1881; nothing had been done on the Fort Hale Bar.

In the Annual Report for 1879, a dike at Sandy Point (opposite Fort Hale) was suggested as a means of increasing the depth on Fort Hale Bar, but on account of its expensiveness was not recommended to be undertaken until dredging had been tried again.

In the Annual Report for 1880 (Part I, page 445), Colonel Barlow renews his recommendation for dredging a channel through Fort Hale Bar 500 feet wide and 16 feet deep.

In the Annual Report for 1881 (Part I, page 592), after current ob-

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servations and borings had been made, a dike from Sandy Point is recommended, the length to be determined experimentally as construction progresses, but to be at least 4,400 feet, which length was estimated to cost $60,000.

Under appropriation of $30,000, made August 2, 1882, a plan for this dike was submitted and referred to the Board of Engineers, by whom it was slightly modified and approved October 2, 1882. The project as approved consisted of a dike connected with Sandy Point by a shore-arm about 2,160 feet long, and extending southward as a channel-arm about 3,200 feet, the channel-arm and part of the shore-arm to be built of creosoted piling in double rows filled in with stone. In 1883, the location of the shore-arm was modified, upon the request of oyster-growers in the vicinity, and in 1886 the method of construction was modified in order to use riprap instead of creosoted piling, the latter being found more expensive both to construct and to keep in repair.

The appropriations of 1882 and 1886 were expended upon the dike, building rather more than one-half of the work. The appropriation of 1884 was expended in dredging under a special project for widening the channel above Long Wharf with depths of 8 and 12 feet, and for removing part of the piers and abutments of Tomlinson's Bridge, just above the steam-boat wharf, which bridge was at that time being rebuilt.

The present project for making a 16-foot channel across Fort Hale Bar includes the completion of the dike at an estimated cost of $46,000 and dredging a channel 16 feet deep through the bar, which, for 400 feet width, is estimated to cost $47,000; total cost, $93,000 (see revised estimates, Annual Report of the Chief of Engineers for 1887, Part I, pages 599 and 600.)

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract for extending the dike from Sandy Point, which in June, 1887, was awarded to Owen J. Conley, of Guilford, Conn., was executed under date of July 1, 1887. The contract provided for building about 450 linear feet of dike extension, using riprap, to be furnished and delivered in place at a cost of $1.03 per gross ton. Work under this contract was begun August 27, 1887, and the contract, being twice extended, was completed January 28, 1888. The total amount of stone delivered in the dike was 4,951 tons, and the length of work built was 570 feet.

PRESENT CONDITION OF IMPROVEMENT.

The available depth over Fort Hale Bar is about 13 feet at mean low water. Above this bar there is a 16-foot channel up to Tomlinson's Bridge, at the head of the harbor, with from 400 to 600 feet width. Just below the Sewer Dock, on the west side of the channel, is an anchorage basin of about 2 acres area and 8 feet depth, and on the east side of the channel above Long Wharf an additional width of about 100 feet has been dredged 12 feet deep or over.

Of the Sandy Point Dike, the shore-arm, 2,140 feet long and 1,359 feet of the channel-arm (including an ice-breaker 20 feet long) has been built; 1,294 feet of the inner end of the shore-arm are of riprap; the outer part of the shore-arm, 846 feet long and 254 feet at the north end of the channel-arm, is built of two rows of creosoted piling, 8 feet apart

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from out to out, and filled in with stone; 1,085 feet of the channel-arm south of the pile-work are built of riprap, of which the north 273 feet are on a log foundation; the ice-breaker at the north end of the channel-arm is also of heavy riprap on log foundation.

PROPOSED OPERATIONS.

With future appropriations the dike will be completed and the channel dredged through Fort Hale Bar. The estimated cost of this is $93,000, to which should be added an estimate of $5,000 annually required for maintenance of channels and for repair of dike.

Appropriations for the improvement of New Haven Harbor have been made as follows, viz:

Date.	Application.	Amount.
Aug. 30, 1852	Removal of Middle Rock, not expended until 1867	$6,000
July 11, 1870	Removal of rocks	15,000
Mar. 3, 1871	Dredging (13 feet) above Fort Hale	40,000
June 10, 1872	Dredging (16 feet) Fort Hale Bar; removal of rocks	35,000
Mar. 3, 1873	Dredging (16 feet) Fort Hale Bar	25,000
Mar. 3, 1875	Dredging (13 feet) above Long Wharf	10,000
June 18, 1878	Dredging (16 feet) Long Wharf to Fort Hale	25,000
Mar. 3, 1879	Dredging (16 feet) above Long Wharf	15,000
June 14, 1880	ditto	15,000
Mar. 3, 1881	Dredging (16 feet) Long Wharf to Fort Hale	15,000
Aug. 2, 1882	Sandy Point Dike	30,000
July 5, 1884	Dredging (18, 12, and 8 feet) above Long Wharf	10,000
Aug. 5, 1886	Sandy Point Dike	20,000
	Total	261,000

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 3½ miles from Long Island Sound. There is a light-house on Southwest Ledge, at the mouth of the harbor. Fort Hale, 2 miles below the city, commands the channel.

Money statement.

July 1, 1887, amount available	$7,818.93
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,488.95
July 1, 1888, balance available	1,329.98
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,329.98
Amount (estimated) required for completion of existing project	78,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	78,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract for improving New Haven Harbor, Connecticut, in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date.	Subject.	Price per ton.	Remarks.
Owen J. Conley, Guilford, Conn.	July 1, 1887	Delivery of riprap and extension of dike.	$1.03	Contract completed January 28, 1888.

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COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

FOREIGN COMMERCE.

Value of imports	$580,054.16
Value of exports	$1,349,655.06
Revenue receipts	$257,811.64
Vessels entered from foreign ports	35
Vessels cleared for foreign ports	20

DOMESTIC COMMERCE.

	Tons.	Value.
Receipts	1,553,700	$84,787,300
Shipments	549,000	Not known.

VESSELS ARRIVING AND DEPARTING.

[Draught, 8 to 20 feet; tonnage, 100 to 1,400 tons.

	Number.
Steamers	6,930
Sail-vessels	9,000
Barges	6,540
Total	22,470

D 6.

CONSTRUCTION OF BREAKWATER AT NEW HAVEN, CONNECTICUT.

New Haven Harbor is the only accessible natural harbor of any considerable area and depth in Long Island Sound between New London Harbor, 45 miles east, and Huntington Bay, 32 miles southwest. At this point Long Island Sound is at its widest, and the broad, open mouth of the harbor left the anchorage ground exposed to storms from a southerly quarter, so that vessels driven in by stress of weather were frequently obliged to cross Fort Hale Bar, going from 2 to 4 miles up the harbor, and to anchor in the dredged channel in order to reach secure shelter.

PROJECT.

December 15, 1874, the harbor commissioners of New Haven addressed a memorial to the members of Congress from Connecticut asking that measures be taken "to procure appropriations by Congress for deepening the main ship-channel of the harbor to 20 feet, and for constructing a breakwater from the light-house" (then on Five-Mile Point) "to Southwest Ledge." The memorial, printed in House Ex. Doc. No. 162, Forty-third Congress, second session, stated that the breakwater contemplated would add greatly to the value of the harbor as a harbor of refuge.

January 21, 1875, a resolution was passed by the House of Representatives asking "for a report from surveys already made, in regard to the expediency of widening and deepening the main channel of New Haven Harbor, Connecticut, to a depth not exceeding 20 feet; and also the expediency and estimate of expense of a breakwater between the eastern shore of the entrance of said harbor and Southwest Ledge, so

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called, or such part of said distance as may be found most expedient or necessary for the protection of said harbor." In reply to this resolution a report was made by Col. J. W. Barlow, Corps of Engineers, dated January 27, 1875, printed in House Ex. Doc. above mentioned and also in the Annual Report of the Chief of Engineers for 1875, Part II, page 251, suggesting three locations for a breakwater, viz:

1. That indicated in the resolution and terminating at Southwest Ledge.

2. A line running nearly east and west, its middle point resting upon Adam's Fall Rock, about one-half mile north of Southwest Ledge.

3. A line 400 yards further north, running nearly west from Five-Mile Point.

Estimates of cost ranging from $248,000 to $465,330 were submitted, and with the report were also presented letters and commercial statistics bearing upon the subject. The question of a westerly breakwater does not appear to have been considered at that time.

This report is referred to by Colonel Barlow in the succeeding Annual Reports for 1876, 1877, and 1878, and in the latter year additional statistics were submitted, but no action was taken until 1879, when an appropriation of $30,000 was made "for the construction of breakwater at New Haven, Conn." In August of the same year an examination of part of the mouth of the harbor was made, and a map transmitted to the Chief of Engineers with several projects for breakwaters, which were referred to the Board of Engineers for report. The report of the Board, dated November 24, 1879, and printed in the Annual Report of the Chief of Engineers for 1880, Part I, pages 449–452, recommended a breakwater from Southwest Ledge to Quipes Ledge as contemplated in the resolution of the House of Representatives of January 21, 1875, but as the anchorage ground would still be exposed to southwesterly gales, the Board stated as its opinion that a breakwater extending northwest from Luddington Rock would be necessary. Their plan provided for two riprap breakwaters, 12 feet wide on top, rising 6 feet above high water, with exterior slopes of one-third and interior slopes of two thirds with estimates as follows:

ESTIMATE FOR BREAKWATER FROM LIGHT-HOUSE LEDGE TO QUIXES LEDGE.

Length of construction	yards..	1,100
Average height of work	feet....	32
Average cross-section	yards..	299
Cost per cubic yard		$2.00
328,900 cubic yards, at $2		$657,800

ESTIMATE FOR BREAKWATER IN THE VICINITY OF LUDDINGTON ROCK.

Length	yards.....	1,400
Average height	feet	28
Cross-section	square yards..	233⅓
326,667 cubic yards, at $2		$653,334

This plan locates the easterly breakwater so as to lie between Light-house Ledge (or Southwest Ledge) and Quixes Ledge, and the westerly one to extend in a northwest and southeast direction overlying Luddington Rock. This report was transmitted to the Secretary of War by the Chief of Engineers, with suggestion that the appropriation ($30,000) be applied toward the construction of the easterly breakwater, and was approved by him January 31, 1880. Before work had been begun the details of cross-section were modified with approval of the Chief of Engineers, so that the exterior slope should be ½ and the interior ÷.

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The first load of stone was delivered April 22, 1880, beginning the east breakwater at the end resting upon Southwest Lodge; under subsequent appropriations it has been extended northeasterly, and up to July 1, 1887, 2,412 lineal feet of this breakwater has been built, using 212,541 tons of granite.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract dated October 22, 1886, with T. J. Allen, of New York City, for delivering about 57,000 tons of granite in the breakwater at the rate of $1.12 per ton, which was in progress at the beginning of the fiscal year, was extended to December 31, 1887, under which extension it was completed, 55,822 tons of granite having been delivered and 656 lineal feet of the breakwater built under the contract. Of these amounts 33,179 tons of stone were delivered and 391 lineal feet of breakwater constructed since July 1, 1887.

Under the unexpended balance of the last appropriation, proposals for further extension of the east breakwater were received April 21, 1888, and a contract dated May 11, 1888, was entered into with John Beattie, of Leete's Island, Connecticut, for delivering about 6,000 tons of granite. Work under this contract began May 22, and is now in progress, the contract expiring September 28, 1888; up to June 30, 1888, 1,251 tons of granite were delivered and 15 lineal feet of the breakwater built.

During the past fiscal year the total amount of stone received is 34,430 tons, and the total length of breakwater built is 406 feet.

PRESENT CONDITION OF WORK.

The east breakwater is now 2,818 feet long, being nearly seven-eighths of its projected length of 3,300 feet. It contains 246,971 tons of stone, and has cost (supervision, etc., included) about $100 per linear foot. The part first built has settled somewhat and needs repairing.

PROPOSED OPERATIONS.

With future appropriations it is proposed, first, to complete the east breakwater, and then to build the west one. About $40,000 will be required to finish the east breakwater. Should sufficient appropriation be made work on both could be prosecuted at the same time.

In its report of November 24, 1879, the Board of Engineers states as its opinion "that after the completion of a certain portion of the easterly breakwater the westerly one should be promptly commenced." Appropriations have not heretofore been sufficiently large to justify working in both places, but the easterly breakwater will soon be completed, when work upon the westerly one will be begun. The question now is as to its location. In reference to this the Board says: "If it be built in a northwest and southeast direction it would cover not only the deep-water anchorage, but to some extent the harbor above." As the object of the westerly breakwater was to protect the anchorage from southwesterly gales and the length was fixed at 4,200 feet, it is evident that it should have a northwesterly direction from Luddington Rock; a breakwater of that length in a southwesterly direction would afford no protection from southeasterly gales.

The harbor commissioners of New Haven have expressed a desire that the location of the westerly breakwater be changed so as to extend in

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a southwesterly direction from Luddington Rock, and that its length be increased, on the ground that the harbor of refuge under the present project is not of sufficient capacity. A supplementary report will be submitted as to the necessity of thus increasing the capacity of the harbor.

During the ensuing year $500,000 could be profitably expended in completing the easterly breakwater and in beginning the westerly one, whether the location and length of the latter be modified or not.

Appropriations for the New Haven Breakwater have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1879	East breakwater	$30,000
June 14, 1880	....do	30,000
Mar. 3, 1881	....do	60,000
Aug. 2, 1882	....do	60,000
July 5, 1884	....do	40,000
Aug. 5, 1886	East breakwater (partially expended)	75,000
	Total	295,000

New Haven, the port of entry for the collection district of New Haven, is situated at the head of New Haven Harbor, about 4 miles north of the breakwater. There is a light-house on Southwest Ledge, at the west terminus of the east breakwater. Fort Hale, 2 miles north of the breakwater, commands the channel.

Money statement.

July 1, 1887, amount available		$47,977.49
July 1, 1888, amount expended during fiscal year, excusive of liabilities outstanding July 1, 1887	$39,786.28	
July 1, 1888, outstanding liabilities	1,688.85	
July 1, 1888, amount covered by existing contracts	6,411.15	
		47,886.28
July 1, 1888, balance available		91.21
Amount appropriated by act of August 11, 1888		75,000.00
Amount available for fiscal year ending June 30, 1889		75,091.21
Amount (estimated) required for completion of existing project		941,134.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for extending the breakwater at New Haven, Conn., opened at Engineer Office, U. S. Army, New York City, April 21, 1888.

No.	Name and address of bidders.	Rate per gross ton.	Total for 6,500 tons.	Remarks.
*1	John Beattie, Leete's Island, Conn	$1.35	$8,775	Granite.
2	Chas. H. Edwards, Quincy, Mass	1.59	10,335	
†3	S. & E. S. Belden, Rocky Hill, Conn	1.16	7,540	Sandstone from Portland, Conn.
4	A. M. Newton, New York City	1.60	10,400	

*Entered into contract May 11, 1888; in progress.

†Lowest bid rejected, with approval of the Secretary of War, May 2, 1888; granite being a better material for the work, and worth the difference in price.

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Abstract of contracts for extending New Haven Breakwater, in force during the fiscal year ending June 30, 1888.

Name and address of contractors.	Date.	Subject.	Price per ton.	Remarks.
T. F. Allen, New York City,	Oct. 22, 1886	Delivering riprap and extending breakwater.	$1.12	Contract completed December 31, 1887.
John Beattie, Leete's Island, Conn.	May 11, 1888	....do	1.35	In progress.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Vessels passing New Haven Breakwater.

Vessels.	No.	Vessels.	No.
Men-of-war	28	Schooners and sloops	15,346
Steam-ships	1,910	Barges in tow.....	19,620
Steamers of all kinds	15,276		
Ships, barks, and brigs	412	Total	52,592

These figures are not complete, as many vessels would pass unobserved in night or in thick weather.

The value of the cargoes of these vessels can not be ascertained; it is undoubtedly very great.

D 7.

IMPROVEMENT OF MILFORD HARBOR, CONNECTICUT.

This harbor is on the north shore of Long Island Sound, about 9 miles southwest of New Haven, Conn. It consists of a broad, open bay, from the head of which the Wepauwog River, a small tidal stream, extends three-quarters of a mile north to the Milford wharves, and the Indian River, another small inlet, extends northeasterly. The mouth of the latter stream is partly closed by a dam, formerly used to create power for a tide-mill.

The original depth on the bar just outside the mouth of the rivers was less than 2 feet at mean low water, and in some places between there and the upper wharves low tide left the channel nearly bare.

The mean rise of tide is 6.2 feet.

PROJECTS FOR IMPROVEMENT.

A survey of breakwater at Milford, Conn., was ordered by Congress in the river and harbor act of 1872. There being no breakwater, a survey of the harbor for a breakwater was made, and in his report dated December 24, 1874 (printed as part of Ex. Doc. No. 107, Forty-second Congress, third session, and also on page 1041 of the Annual Report of the Chief of Engineers for 1873), General Warren, U. S. Engineers, submitted the following plan of improvement:

1. A riprap breakwater from Welch's Point, on the east side of the mouth of the harbor..... $67,000
2. Protecting the bluffs on the east shore from erosion by means of small stone jetties 5,500
3. Dredging 4 feet deep and 100 feet wide across the bar at the mouth of the river 6,250

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4. A jetty on the east side of the channel, to prevent the dredged area from filling and to confine the action of the tide	$5,000
Superintendence	1,250
Total	85,000

In 1874 $5,000 was appropriated for this harbor, and work under the above project was begun, building the small jetties to protect the east shore. Twelve such jetties were built, 100 to 130 feet long, and rising to 9 feet above mean low-water level. The appropriation of 1875 ($13,000) was applied to repair of these jetties, to construction of a jetty from the east shore, at the mouth of Indian River (Long Jetty), and to dredging across the bar.

In the annual report for 1876 (see Annual Report of the Chief of Engineers for 1876, Part I, page 225) Colonel Barlow, U. S. Engineers, recommended that the dredged channel be carried up to the Town Wharf, about half a mile farther up, at an additional estimated cost of $9,000. This recommendation was renewed in 1877, and was included in the project for expenditure of the appropriation of $10,000 made in 1878; in that and the following year the 4-foot channel across the bar was completed to 100 feet width as originally projected, and was extended to Town Wharf with width from 60 to 75 feet, and Long Jetty was repaired; also under the same appropriation, in 1879 and 1880, an additional jetty, authorized by Department letter of October 16, 1879, was built on the west side of the channel extending southward from Burns's Point. This appropriation completed the original project except the breakwater; sufficient money for beginning that had not been appropriated.

June 14, 1880, $5,000 was appropriated, and in accordance with a project for its expenditure submitted and approved, the 4-foot harbor channel was extended from Town Wharf to the Straw Works Wharf, at the upper end of the harbor, with a width of 40 feet. This was completed before the appropriation was exhausted and, "at the earnest solicitation of those most interested in the works of improvement there, an experimental channel 25 feet wide and 8 feet deep was cut through the bar at the entrance, lying within and on the west side of the 4-foot channel already made. This is now of great use to the steam-vessels employed in the fish-oil works at that place, and it is claimed that the increase of shipping in the harbor, particularly in the oyster business, for which those waters seem very well adapted, will soon require an 8-foot channel of fully 100 feet width. Such a channel would involve the removal of about 45,000 cubic yards more of material, principally sand and gravel, which, at ruling prices, would cost, including superintendence and incidental expenses, about $11,000." (Extract from Colonel Barlow's annual report of 1881. See Annual Report of the Chief of Engineers for 1881, Part I, pages 598 and 599.)

Under the appropriation of $5,000 made August 2, 1882, the project above suggested was adopted and the 8-foot channel was widened to 65 feet from the bay up to Merwin's Wharf, with 100 feet width around the bend at Burns's Point. No appropriation has since been made.

By act of Congress approved March 3, 1871, a survey for a breakwater and harbor of refuge at Milford Harbor was authorized. The survey was made, and a report with estimates was submitted January 20, 1882. This report is printed in the Annual Report of the Chief of Engineers for 1882, Part I, page 632.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The available funds were not sufficient to continue the improvement.

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PRESENT CONDITION OF IMPROVEMENT.

The channel, dredged 4 feet deep, with width of 60 feet for about two-thirds the distance from the mouth of the river to the Straw Works Wharf, and width of 40 feet the rest of the distance, is understood to be in good condition, having filled but little. The channel across the bar, 8 feet deep and 65 feet wide, has shoaled in places, especially near the outer end, so that the available depth at low water is now less than 7 feet.

Long Jetty, on the east bank of the mouth of Indian River, needs considerable repair; the other jetties slight repairs.

PROPOSED OPERATIONS.

Future appropriations should be applied to repairing the jetties and to completing the 8-foot channel through the bar to 100 feet width; $6,000, the remainder of the estimate, could be profitably expended during the next fiscal year to complete the project.

Appropriations for improving Milford Harbor have been made as follows, viz:

Date.	Appropriation.	Amount.
June 10, 1872	Survey	$1,500
June 23, 1874	Jetties on east shore	5,000
Mar. 3, 1875	Long Jetty and dredging at mouth of river	13,000
June 18, 1878	Dredging to Town Wharf	10,000
June 14, 1880	Dredging above Town Wharf and (8 feet) below Merwin's Wharf, on bar	5,000
Mar. 3, 1881	Survey for breakwater	100
Aug. 2, 1882	Dredging (8 feet) on bar	5,000
	Total	39,600

Milford Harbor is in the collection district of New Haven; it is about 9 miles west from Fort Hale, New Haven Harbor. The nearest light-house is on Stratford Point, 4 miles to the westward.

Money statement.

July 1, 1887, amount available	$241.02
July 1, 1888, balance available	241.02
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,241.02
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

No recent statement of commerce has been received; the present amount is probably not very different from that of 1884, when the following figures were submitted.

ARRIVALS AND DEPARTURES OF VESSELS.

Vessels.	Number.	Tonnage
Steamers	560	23,520
Sail-vessels	318	12,720
Total	878	36,240

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The chief articles of commerce are:

Coal	tons..	10,000
Building materials	do...	2,500
Oysters	value..	$78,750
Fish-oil and fertilizers		not known.

The value of the oyster business is supposed to have increased somewhat, and that of the fish-oil and fertilizer factories to have diminished since 1884.

D 8.

IMPROVEMENT OF THE HOUSATONIC RIVER, CONNECTICUT.

The Housatonic is a long, shallow river, running southward through Massachusetts and Connecticut and emptying into Long Island Sound just east of Stratford Point, about 15 miles southwest from New Haven. At Derby, 13 miles above its mouth, it receives the discharge of the Naugatuck, a small rapid river. This point, which has been regarded as the head of navigation, is nearly the head of tide-water; about a mile above there is a dam across the Housatonic River, furnishing large water-power. For at least 5 miles below Derby the water is always fresh.

The original depth on the worst bars in the river (six in number) was from 3.5 to 4.5 feet at mean low water; there was also a bar across the river's mouth, with about 4 feet, low-water depth.

PROJECTS FOR IMPROVEMENT.

In pursuance of a resolution of the House of Representatives, dated December 20, 1869, authorizing a survey of the Housatonic River below Derby, which resolution was referred by the Secretary of War to the Chief of Engineers for report as to "the necessity for the survey," an examination of the river from Derby to Long Island Sound was made by Col. D. C. Houston, Corps of Engineers, who reported January 8, 1870, recommending a detailed survey of all that part of the river, at an estimated cost of $5,000. This report was printed in House Ex. Doc. No. 62, Forty-first Congress, second session.

By act of Congress, approved July 11, 1870, a survey of the Housatonic River below Derby, Conn., was directed, and an allotment of $2,700 was made for a survey "sufficient to determine the prominent obstructions to navigation." In his report on this survey, dated January 23, 1871, and printed in House Ex. Doc. No. 95, Forty-first Congress, third session, also in the Annual Report of the Chief of Engineers for 1871, page 781, General G. K. Warren, Corps of Engineers, submits the following estimates for making a channel 7 feet deep at mean low water, to be 200 feet wide over the bar at the mouth of the river, and 150 feet wide in the river, the channel at the river's mouth to be protected on the east side by a breakwater from Milford Beach:

Jetty at Sow and Pigs Reef	$4,000
Removing Drew's Rock, 357 cubic yards	2,000
Dredging inside the bar at the mouth	18,486
Dredging in the bar at the mouth	12,000
Construction of breakwater at mouth	368,475
Total	404,961

The breakwater was to be built of riprap up to 1½ feet above mean low water and of dimension stone above; it was to be 6 feet wide on top,

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rising to 11 feet above low water, and was to extend to the 6-foot curve, an estimated length of 4,200 feet.

March 3, 1871, the first appropriation for improvement of the river was made and work in accordance with the project was begun. In 1872 the project was modified to admit of a jetty connecting Drew's Rock with the west bank, instead of removal of the rock; this was done on the ground of economy, and the jetty was built in 1872. The result has been to form a bar below the jetty, which required such frequent dredging that it has been found expedient to remove the rock, as originally projected.

Appropriations were not made in sufficient amount to warrant beginning the breakwater as originally designed, and in 1879 Colonel Barlow proposed to substitute for it a riprap jetty at an estimated cost of $12,000; in 1882 the estimate was changed to $20,250, the contemplated jetty being 6,000 feet long and rising only to low-water level. Such a jetty could subsequently be built higher if necessary, and there seems no doubt that this would have to be done before any useful effect could be realized; therefore, in my Annual Report for 1887 (see Annual Report of the Chief of Engineers for 1887, Part I, page 607), I presented revised estimates for a breakwater, modifying the originally proposed method of construction to one for using riprap only, experience at harbors on Long Island Sound having shown this construction to be as durable as dimension stone-work and more economical. At the same time estimates, based on recent surveys, were submitted for the dredging necessary to make the channel 7 feet deep, with width of 200 feet at the mouth of the river and 100 feet above; the latter width was adopted in 1883, because up to that time the originally proposed width of 150 feet had never been obtained.

Following are the estimates for the breakwater and for dredging, submitted in 1887:

For a breakwater 5,750 feet long, extending from Milford Beach 3,250 feet in a course about south-southeast: thence parallel with and 500 feet from the channel, 2,500 feet further to the 12-foot curve; inside the bend to be built up to 3 feet above mean low water, top width 6 feet, side slopes 1 on 1; outside the bend to be built up to 6 feet above high water, top width 12 feet, outer slope 1 on 2, and inner slope 1 on 1	$175,000
For dredging at the mouth of the river and at six bars in the river, 146,000 cubic yards, at 16 cents, with about 15 per cent. added for contingent expenses	27,000
Total	202,000

To which should be added about $4,000 annually, required for maintenance of the channels.

January 27, 1887, a letter further explaining the reasons for the new estimate for the breakwater was submitted to the Chief of Engineers, and was subsequently printed as Senate Ex. Doc. No. 103, Fiftieth Congress, first session, a copy of which paper is attached to this report.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract for removal of Drew's Rock and Jetty, which was in progress at the time of the last annual report, was extended to June 30, 1888, under which extension it was completed early in June. A depth of 7 feet at mean low water was made over the rock.

A series of tidal observations were made in the river in May and June, 1888, to correct old tide-levels and establish new ones. This was especially important at the mouth of the river, where mean low-water levels vary 1¾ feet in a distance of less than 2½ miles.

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PRESENT CONDITION OF IMPROVEMENT.

The available depth on the several bars in the river is from 5 to 6 feet at mean low water; on the inner bar, at the mouth of the river, the present depth is about the same.

Drew's Rock and Jetty have been removed.

PROPOSED OPERATIONS.

With future appropriations it is proposed to construct the breakwater at the mouth of the river to widen and deepen the channel there, and to restore and maintain a depth of 7 feet at mean low water on the bars in the river.

The estimated cost of this work is $202,000, to which should be added about $4,000 annually required for maintenance of channels.

Appropriations for the Housatonic River have been made as follows, viz:

Date.	Application.	Amount.
Mar. 2, 1867	Examination	$42
July 11, 1870	Survey	2,700
Mar. 3, 1871	Sow-and-Pigs Jetty; dredging	15,000
June 10, 1872	Drew's Rock Jetty; dredging	15,000
Mar. 3, 1873	Dredging	10,000
June 23, 1874	....do	10,000
Mar. 3, 1875	....do	5,000
June 18, 1878	....do	5,000
June 14, 1880	....do	2,000
Mar. 3, 1881	....do	2,000
Aug. 2, 1882	Removing Drew's Rock and Jetty, 1887	2,000
July 5, 1884	....do	2,500
Aug. 5, 1886	....do	5,000
	Total	76,242

The Housatonic River is the boundary between the collection districts of New Haven and Fairfield. The nearest light-house is on Stratford Point, at the mouth of the river, and the nearest work of defense is Fort Hale, New Haven Harbor, about 15 miles east.

Money statement.

July 1, 1887, amount available		$6,975.37
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$825.96	
July 1, 1888, outstanding liabilities	4,444.00	
		5,269.96
July 1, 1888, balance available		1,705.41
Amount appropriated by act of August 11, 1888		35,000.00
Amount available for fiscal year ending June 30, 1889		36,705.41
Amount (estimated) required for completion of existing project		167,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of contract for removal of Drew's Rock and Jetty, Housatonic River, Connecticut, in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date.	Subject.	Price for whole work.	Remarks.
Francis H. Smith, New York City.	Oct. 26, 1886	Removal of Drew's Rock and Jetty.	$4,444	Contract completed in June, 1888.

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Commercial statistics for the calendar year of 1886.

	At Stratford, near mouth.	At Derby, head of navigation.	Total.
Arrivals and departures of vessels	575	460	1,035
Tons of cargo received and shipped	25,000	44,301	69,301
Value of cargo received and shipped	$350,000	$3,250,000	$3,600,000

SPECIAL REPORT OF LIEUTENANT-COLONEL D. C. HOUSTON, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
New York, January 27, 1888.

SIR: I would respectfully call your attention to the estimate in the Annual Report of the Chief of Engineers for 1887, "for completion of existing project, $25,000," Housatonic River, Connecticut.

The original project for this improvement is based on a survey made in pursuance of the river and harbor act of July 11, 1870. (Annual Report of the Chief of Engineers for 1871, page 781.) The estimate was as follows:

Breakwater at mouth of river	$368,475
Dredging at mouth	12,000
Dredging on bars above mouth	24,486
Total	404,961

No estimate for completion of project appears in the annual reports until 1884, when an estimate of $30,000 is given for completion. This includes $20,000 for a riprap jetty 6,000 feet long, rising only to low water, as a substitute for the original plan of breakwater. The sum of $5,000 having been since appropriated (1886) reduces this estimate to $25,000, of which $20,000 is for breakwater and $5,000 for dredging. As explained in my annual report for 1887, I consider this project and estimate inadequate, and for this reason the estimate for completion should be increased before any breakwater is commenced.

The amount given for this purpose in my annual report for 1887 is $202,000, of which $175,000 is for a breakwater at the mouth of the river, and $27,000 for dredging on bars from the mouth up to Derby. I inclose an extract from my annual report explaining this estimate.*

The reason why my estimate for a breakwater is so much less than the original is due to the method of construction. There is a drawing on page 782, Annual Report of the Chief of Engineers for 1871, showing the original design. From experience at New Haven and other locations, I think a riprap structure will answer the purpose at much less cost. General Warren and other officers in charge of the work have also arrived at this conclusion.

No dredging has been done at the mouth of the river except by private parties with whom contracts have been made to do the work under direction of the officer in charge, the compensation being the material excavated, which was valuable for oyster beds. The channel thus deepened has filled, to some extent with sand, so that this arrangement can not be continued. The necessary depth on the bar could be maintained by annual dredging, but the estimate now presented to Congress provides only $5,000 for dredging in the entire river. This would not

* Omitted here.

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be sufficient to do the work required above the mouth, which is of the first importance.

Unless the estimate for completion is increased the project for a breakwater should be abandoned. This was practically the case up to 1882, when the estimate of $20,000 was made, as the amounts appropriated were not sufficient to warrant the commencement of the breakwater in the original estimate.

Very respectfully, your obedient servant,

D. C. HOUSTON,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D 9.

IMPROVEMENT OF BRIDGEPORT HARBOR, CONNECTICUT.

This harbor extends nearly 3 miles inland from the north shore of Long Island Sound, its width of about 1 mile at the mouth decreasing to 200 feet between opposite wharves at its upper end. The channel, even in the widest part of the harbor, is comparatively narrow.

Before the first work by the United States was done at this harbor the depth over the bars was about 5 feet at low water, equivalent to 11½ feet at high water.

PROJECTS FOR IMPROVEMENT.

In 1833 a petition of citizens of Bridgeport was presented to Congress asking an appropriation of $10,000 to improve the harbor; this was granted in 1836, and the agent in charge was instructed by the Engineer Department to dredge a channel 8 feet deep, making it 200 feet wide through the outer bar and 100 feet wide through the inner bar, or as much as the appropriation would admit of; the work was done by contract in 1837; the rate was high (understood to be 72.8 cents per cubic yard) and the funds were exhausted when the channel through the outer bar had been made 60 feet wide.

In 1838 Captain Swift, U. S. Engineers, reported that the channel had been sounded and was found to be 12 feet deep, or 4 feet deeper than when left by the dredger.

Nothing further was done until 1852, when a second appropriation of $10,000 was made; Captain Dutton, U. S. Engineers, found that the channel on the outer bar was then 6 feet deep and 90 feet wide, and on the inner bar but 5 feet deep, and he submitted a project for dredging through both bars to a depth of 8 feet and width of 200 feet, at a total estimated cost of $32,000; this project was approved by the Secretary of War February 5, 1853, and with the $10,000 then available channels 8 to 13 feet deep were dredged 100 feet wide through the inner bar and 60 feet wide through the outer bar.

By act of Congress approved June 23, 1866, a survey of the harbor was ordered, which was made in that year. The object of the survey was to ascertain "the present state of the harbor and the character and extent of the encroachments upon it by the action of the tides," it being feared that Long Beach on the east side of the harbor's mouth was making northwestward by reason of sand drifting along the shore in such a way as to contract and ultimately fill up the channel above the inner bar. This work was at that time in my charge, and in my report on the survey, dated January 12, 1867, I stated that it had been proposed to construct a breakwater extending out from Long Beach to

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arrest the sand, but the danger feared did not seem imminent and I recommended a series of observations for the purpose of ascertaining the nature and amount of changes taking place.

In 1867 a survey of the shore-line of Long Beach was made.

In 1868 I was directed by the Chief of Engineers to make "such resurvey of Bridgeport Harbor Connecticut, as may be found necessary to ascertain what changes have occurred since the survey of 1866." In my report on this survey I said that the channel remained the same and that no appropriation was needed until "the channel is found to be inadequate to the necessities of commerce, and then dredging must be resorted to."

In 1870 a petition of citizens of Bridgeport was presented to Congress asking that an appropriation "be made to remove said sand-bar" (the outer bar) "and to widen and deepen said channel and harbor in order that vessels drawing 12 feet of water may be enabled to enter without being grounded and without the aid of lighters," and a survey or examination of the harbor was ordered. The work was then in charge of General Warren, U. S. Engineers; he made an examination of the harbor and found it unnecessary to make further surveys. In his report, dated January 12, 1871, General Warren submits a project for dredging a channel 100 feet wide and 12 feet deep at extreme low water (or 14 feet at mean low water), and for building a pier 3,000 feet long extending out from Long Beach, to be partly of riprap, partly of dolphins; the estimated cost of the project was $124,000. After an appropriation of $20,000 was made in 1871, work under this project was begun, dredging to depths of 12 and 13 feet at mean low water, and substituting a riprap jetty for the riprap and dolphins; the jetty was completed as far as deemed necessary in 1873. In 1875 the dimensions of the projected channel were modified, so as to make it 12 feet deep at mean low water and from 200 to 300 feet wide; this was accomplished in 1882.

In 1878, in compliance with the terms of the appropriation act of that year, a channel 100 feet wide and 9 feet deep was dredged from the Lower Bridge to the Horse-railroad Bridge, a distance of about 3,000 feet.

After the appropriation of 1882, a project for widening to 600 feet the channel between the inner beacon and the Naugatuck Railroad Wharf was adopted, to prevent overcrowding of the main channel by vessels entering to seek refuge during storms; the estimated cost was $60,000. This is nearly completed, a small area near the inner beacon remaining to be dredged.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Under the unexpended balance of the last appropriation, proposals were received for dredging to remove a shoal point on the west side of the channel near the Inner Beacon, and a contract, dated May 16, 1888, was entered into with Messrs. Henry DuBois Sons, of New York City, to dredge about 14,000 cubic yards at the rate of 14 cents per yard. Work under this contract was begun June 19, and completed June 30, 14,000 cubic yards being removed from the southeast part of the shoal point, making 12 feet depth at mean low water when the depth had been from 5 to 12 feet.

PRESENT CONDITION OF IMPROVEMENT.

The 12-foot channel is 75 feet wide on the outer bar, but for 200 feet width there is a depth of 11 feet or over; thence across the inner bar and up to the inner beacon the 12-foot channel is about 300 feet wide;

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thence up to the Naugatuck Railroad Wharf it is 600 feet wide; above that wharf it has shoaled so that the present depth is from 10 to 11 feet.

The breakwater out from Long Beach has settled since it was built; it still serves the purpose for which it was designed and no repairs are now needed.

The project of 1882 for making 600 feet width of channel between the Inner Beacon and the Naugatuk Railroad Wharf was reported in the last annual report as completed. The inner beacon has been rebuilt and its location slightly changed, which mades it desirable to cut off a shoal point outside the new position of that beacon; this has been nearly finished under a contract just completed.

PROPOSED OPERATIONS.

The channel from the Naugatuck Railroad Wharf up to the Lower Bridge has shoaled about 2 feet. With future appropriations it is proposed to remove the shoals and to widen the channel eastward to the harbor line an additional width of about 200 feet. The estimated cost of this work is $17,000 (for details of estimate see Annual Report of the Chief of Engineers for 1887, Part I, page 611); it could de done to advantage in a single year.

The annual cost of maintaining the dredged channel in this harbor is estimated at $2,000.

Appropriations for the improvement of Bridgeport Harbor have been made as follows, viz:

Date.	Application.	Amount.
July 4, 1836	Dredging outer bar	$10,000.00
Aug. 30, 1852	Dredging outer and inner bars	10,000.00
June 23, 1860	Survey	1,985.38
July 11, 1870	....do	500.00
Mar. 3, 1871	Dredging and 521 feet of breakwater	20,000.00
June 10, 1872	Dredging and 859 feet of breakwater	40,000.00
Mar. 3, 1873	Dredging inner bar and upper harbor	30,000.00
June 23, 1874	Dredging, bridge to Long Island Sound (9 feet)	20,000.00
Mar. 3, 1875	Dredging, bridge to Long Island Sound (12 feet)	15,000.00
Aug. 14, 1876	Dredging upper harbor (9 feet)	10,000.00
June 18, 1878	Dredging above bridge and outer bar (9 and 12 feet)	10,000.00
Mar. 3, 1879	Dredging, bridge to Long Island Sound (12 feet)	10,000.00
June 14, 1880	....do	10,000.00
Mar. 3, 1881	Dredging above inner beacon (12 feet)	10,000.00
Aug. 2, 1882	Dredging between inner beacon and railroad wharf (12 feet)	10,000.00
July 5, 1884	....do	5,000.00
Aug. 5, 1886	....do	20,000.00
	Total	232,485.38

Bridgeport, the port of entry for the collection district of Fairfield, is situated about 2 miles from Long Island Sound, at the head of Bridgeport Harbor. There is a lighthouse at the entrance to the harbor. Fort Hale, New Haven Harbor, the nearest work of defense, is 18 miles east.

Money statement.

July 1, 1887, amount available		$2,478.07
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$321.01	
July 1, 1888, outstanding liabilities	1,960.00	
		2,281.01
July 1, 1888, balance available		197.06
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,197.06
Amount (estimated) required for completion of existing project		7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		7,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids for dredging in Bridgeport Harbor, Connecticut, opened at Engineer Office, U. S. Army, New York, April 21, 1888.

No.	Names and address of bidders.	Rate per cubic yard.	Total for 30,000 cubic yards.	Remarks.
		Cents.		
1	Townsend & Fennell, Boston, Mass	19	$5,700.00	But one bid received.
2	Alonzo J. Beardsley and George D. Beardsley, West Stratford, Conn.	14⅝	4,387.50	Date of beginning work was changed by bidders to "on or before June 15, 1888."
*3	Charles DuBois and Henry N. DuBois, New York City.	14	4,200.00	
4	Hartford Dredging Company, Hartford, Conn.	16	4,800.00	

* Entered into contract May 16, 1888; contract completed June 30, 1888.

Commercial statistics for the calendar year of 1888.

	No.	Tonnage.
Foreign commerce:		
Arrivals	10	1,365
Departures	8	1,605
Domestic commerce: Arrivals and departures	15,939	1,195,760

ESTIMATED VALUE OF CARGOES.

Receipts	$39,000,000
Shipments	38,000,000

VESSELS ARRIVING AND DEPARTING.

(Draught, 6 to 18 feet; tonnage, 50 to 1,200 tons.)

	Number.
Steamers	4,911
Sailing vessels	5,509
Barges	5,519
Total	15,939

Vessels carrying 212,000 tons of coal entered the harbor for refuge during 1886.

D 10.

IMPROVEMENT OF BLACK ROCK HARBOR, CONNECTICUT.

This harbor, 1½ miles long from northeast to southwest, and from 300 to 2,500 feet wide, lies between the mainland on the west and Fairweather Island on the east, and includes the navigable part of Cedar Creek, a small tidal inlet which extends up into the western part of the city of Bridgeport, and affords water communication of great value to several large manufactories in its immediate neighborhood. It is in the interest of the city of Bridgeport that the improvement of Black Rock Harbor is desired.

The depth in the lower part of the harbor is from 6 to 12 feet at mean low water; this part of the harbor was formerly much used as a refuge for vessels overtaken by storms, but it is not deep enough for most vessels now engaged in commerce through the Sound. Before work was

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done in Cedar Creek the depth there was from 2 to 4 feet, and the channel was narrow and crooked.

The head of the harbor was separated from Long Island Sound on the southeast by a broad, flat sand-bar, which was bare at about half-tide, and which joined Fairweather Island with the main shore.

PROJECTS FOR IMPROVEMENTS.

Between 1836 and 1838 $21,500 were expended in building a sea-wall across a breach in the southern part of Fairweather Island to preserve the light-house reservation at the south end of the island, and to prevent shoaling on the anchorage-ground.

In 1882 a survey of the harbor was ordered by Congress, which was made in 1883. In his report on this survey, dated December 12, 1883, and printed in Senate Ex. Doc. No. 50, Forty-eighth Congress, first session, also in the Annual Report of the Chief of Engineers for 1884 (Part I, page 666), Colonel McFarland, U. S. Engineers, submitted a project providing—

(1) For protecting the upper part of the harbor from the sea by building a breakwater over the bar northeast of Fairweather Island, to be about a half mile long and 6 feet wide at the top, which was to be 3½ feet above mean high water or 10 feet above low water.

(2) For making a channel 80 feet wide and 6 feet deep at mean low water, extending up Cedar Creek.

The estimated cost was—

Breakwater	$58,000.00
Dredging	22,000.00
Total	80,000.00

Work under this project was begun in 1885, and up to July 1, 1887, the breakwater had been built to its full length in order to prevent the currents from cutting a channel across the bar, but its cross-section was less than designed, both in height and width; also a channel had been dredged as far up Cedar Creek as the Forge Company's Wharf, with a width of 57 feet and a depth which was originally made 6 feet at mean low water, but which had shoaled on the southeast side to from 4 to 6 feet.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract of October 22, 1886, with Elijah Brainard, of New York City, for dredging in Cedar Creek, which was in progress at the date of the last annual report, was completed October 14, 1887, 24,868 cubic yards being dredged since July 1, 1887. The total amount of material removed under this contract was 46,368 cubic yards, and the channel was made 60 feet wide and 6 feet deep from the 6-foot curve in the harbor to a point opposite the Forge Company's Wharf, and was extended with a less width about 430 feet farther. During the first part of the work dredged material was mostly pumped up and deposited on the marsh lands for filling, and in order to get more material the contractor frequently dredged deeper than required; the amount thus dredged from below the required depth during the whole contract is estimated at 11,240 cubic yards, which amount was not accepted nor paid for, and is not included in the amount above reported.

PRESENT CONDITION OF IMPROVEMENT.

The sea-wall built in 1836–1838 across a breach in Fairweather Island is still effective in preserving the island and in preventing the sea from washing over into the harbor. It needs some repair.

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The breakwater between Fairweather Island and the mainland is built to its full length, 2,744 feet, with diminished cross-section.

The 6-foot channel has been dredged to the full width projected—80 feet—but that part dredged in 1884 has shoaled nearly 2 feet, so that the present available width of channel is but 60 feet; it extends up the harbor to a point opposite the Forge Company's Wharf.

PROPOSED OPERATIONS.

With future appropriations it is proposed to complete the channel to its projected width of 80 feet, to extend it up the harbor, and to build up the breakwater to the dimensions projected; $20,000 could be profitably expended on the work during the next fiscal year.

Appropriations for the improvement of Black Rock Harbor have been made as follows, viz:

Date.	Application.	Amount.
1836–1838....	Building sea-wall in Fairweather Island	$21,500
Aug. 2, 1882.	Survey	350
July 5, 1884.	Building breakwater and dredging	20,000
Aug. 5, 1886.	Dredging	5,000
	Total	46,850

Black Rock Harbor is in the Fairfield collection district, of which Bridgeport is the port of entry. There is a light-house at the harbor entrance. Fort Hale, New Haven Harbor, the nearest work of defense is, 20 miles east.

Money statement.

July 1, 1887, amount available	$2,531.59
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,391.29
July 1, 1888, balance available	140.30
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,140.30
Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract for improving Black Rock Harbor, Connecticut, in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date.	Subject.	Price per cubic yard.	Remarks.
Elijah Brainard, New York City.	Oct. 22, 1886	Dredging	$0.09	Contract completed October 14, 1887.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

In 1886 there were 13 manufacturing firms located near the head of the harbor, using coal and raw materials amounting to about 40,000 tons annually, of which 23,500 tons were received by water; the rest was carted from Bridgeport or received by rail. The amount of material received by water has nearly doubled since the improvement of the harbor began in 1884.

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D 11.

IMPROVEMENT OF SOUTHPORT HARBOR, CONNECTICUT.

This harbor consists of the mouth of a small stream called Mill River and of a broad, shallow bay on the north shore of Long Island Sound, about 6 miles west of Bridgeport. Before any Government work was done in this harbor the navigable low-water depth was less than 2 feet, and the channel was in danger of being quite filled by drift-sand from the beach to the east.

The mean rise of tide is 6.6 feet.

PROJECTS FOR IMPROVEMENT.

In 1827 a survey of Mill River (Southport Harbor) was made by Lieut. Col. John Anderson, U. S. Engineers, in order to ascertain "the expediency of removing the obstructions to navigation thereof and of protecting the same." With the report on this survey, dated February 19, 1827, was submitted a project for a stone breakwater on the east side of the channel from high water to low-water line, for a dike of earth and sod extending up-stream along the edge of the marsh, and for channel dredging to make 2 feet depth at low water, at an estimated cost of $6,096.18.

By act of Congress approved March 2, 1829, $6,097 was appropriated, and the work was carried out substantially as projected, the breakwater being 1,320 feet long, 8 feet wide at top, which was 8½ feet above common low water, and the dike being 1,350 feet long, 5 feet wide at top, which was 1 foot above high water of spring-tides.

In 1832 $4,490.23 were appropriated "for completing the breakwater and dike, and deepening the channel," and in 1836 and 1837 $2,500 were appropriated for "securing the public works of the harbor of Southport;" these sums, it is understood, were applied to repairing the breakwater, to building storm revetments on either side of the dike, to building beacons, and probably to dredging.

By act of Congress approved July 11, 1870, a survey or examination of Southport Harbor was authorized. General Warren, U. S. Engineers, made an examination of the harbor, and in his report, dated January 14, 1871, and printed in the Annual Report of the Chief of Engineers for 1871, page 823, submitted a plan for repairing and increasing the height of the breakwater and dike, at an estimated cost of $12,225.

March 3, 1875, $5,000 were appropriated "for the repair of the breakwater and piers at the harbor of Southport," which sum was applied to raising the breakwater about 2 feet higher. With an appropriation of $5,000, made in 1876, the dike was repaired and a channel 4 feet deep and 60 feet wide was dredged through the bar at the harbor's mouth.

In his Annual Report for 1878, Colonel Barlow, U. S. Engineers, recommended making the channel 4 feet deep and 100 feet wide, which project was adopted, and under successive appropriations up to 1882 the channel was dredged 95 feet wide up to the south end of the breakwater, thence 80 feet wide up to White Rock, above which point it was prolonged in a Y instead of widening it, in order better to accommodate the harbor commerce. This substantially completed the project and afforded all the harbor facilities that were then desired.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done. The project for improvement is completed, and the money appropriated is nearly all expended.

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PRESENT CONDITION OF IMPROVEMENT.

The breakwater and dike are in fair condition, with no urgent need of repairs. An examination in the fall of 1885 showed no material changes in the channel; it had then an available depth of 4 feet at mean low water as far as dredged.

PROPOSED OPERATIONS.

The approved project is completed, and no repairs or further improvements are required at present.

Appropriations for improving Southport Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 2, 1829	Breakwater, dike, and dredging	$6,097.00
July 3, 1832	Completing breakwater and dike, building beacons, and a small amount of dredging.	4,490.43
July 4, 1836		1,500 00
Mar. 3, 1837		1,000.00
July 11, 1870	Examination and report	500.00
Mar. 3, 1875	Repairs on breakwater	5,000.00
Aug. 14, 1876	Repairs on dike and dredging	5,000.00
June 14, 1880	Dredging upper harbor	2,500.00
Mar. 3, 1881	Dredging on bar	2,500.00
Aug. 2, 1882	Dredging upper harbor	3,000.00
	Total	31,587.43

Southport Harbor is in the Fairfield collection district, about 6 miles west of Bridgeport, which is the port of entry. The nearest light-house is on Penfield's Reef, 3½ miles east of the harbor. Fort Hale, New Haven Harbor, 24 miles east, is the nearest work of defense.

Money Statement.

July 1, 1887, amount available	$79.60
July 1, 1888, balance available	79.60

COMMERCIAL STATISTICS.

No statement of commerce has been received since 1883; it has not materially changed since then, when the following estimates were presented:

Vessels arriving and departing		175
Tonnage		10,500
Average draught	feet..	7
Receipts; coal, lumber, miscellaneous	tons..	6,000
Shipments; chiefly farm produce, valued at		$190,000

D 12.

IMPROVEMENT OF NORWALK HARBOR, CONNECTICUT.

Norwalk Harbor, or River, is a tidal estuary, with a narrow channel extending about 3 miles north from Long Island Sound to the town of Norwalk. Above Norwalk the river is a small fresh-water stream. South Norwalk is on the west bank of the river, 1½ miles below Norwalk. At this point the river is crossed by two bridges; the lower one a wagon

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bridge, and the other, 450 feet above, the bridge of the New York, New Haven and Hartford Railroad.

In 1867 a company was incorporated under the laws of the State of Connecticut for the improvement of this river. Little work was done, and when the improvement was begun by the United States the low-water depth to South Norwalk was 5 feet and to Norwalk but 1 foot.

PROJECTS FOR IMPROVEMENT.

By act of March 2, 1829, Congress appropriated $80 "for making a survey of the harbor of Norwalk, Conn., with a view to its improvement." The survey was made by Capt. Hartman Bache, U. S. Engineers, who, in his report on the same, dated May 10, 1830, recommended excavating the channel, proposing to build a steam-dredge for the purpose, to cost—

For a channel 12 feet deep at ordinary high water	$15,668.95
For a channel 10 feet deep at ordinary high water	12,286.45

No money was appropriated for carrying out this plan, and in 1871 another survey was ordered by Congress, which was made in the same year. In his report upon the latter survey, dated December 16, 1871, and printed in Senate Ex. Doc. No. 23, Forty-second Congress, second session, also in the Annual Report of the Chief of Engineers for 1872, page 900, General Warren, U. S. Engineers, submitted a project for dredging a channel 6 feet deep and 100 feet wide, from Long Island Sound up to Norwalk, at an estimated cost of $34,000. In 1880 the terms of the river and harbor act provided that "so much of said appropriation ($5,000) as shall be necessary therefor shall be so expended as to have a channel 6 feet deep at low water between the steam-boat landing in said Norwalk and Long Island Sound." As a channel of the projected width (100 feet) and depth of 6 feet at *mean* low water already existed, this was interpreted to require a depth of six feet at *extreme* low water (see Annual Report of the Chief of Engineers for 1881, Part I, page 609), which would be 8 feet at mean low water, and the project was accordingly modified to provide for obtaining that depth up to South Norwalk.

The latest estimate, made to include the cost of this modification and of a large amount of dredging already required to maintain the depths, places the total cost from the time of beginning work at $84,000.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done.

PRESENT CONDITION OF IMPROVEMENT.

The channel below South Norwalk, which has been dredged 100 feet wide and 8 feet deep at mean low water, has its full depth, with the width diminished by caving in of the banks, principally on the northeast side of the cut. Above South Norwalk the channel is from 60 to 100 feet wide and 6 feet deep at mean low water.

PROPOSED OPERATIONS.

The estimated amount required to complete the existing project is $7,000, which could be advantageously expended in a single year in

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widening and straightening the channel, and in deepening the parts which have filled in since dredging.

Smaller appropriations will be required from time to time to maintain the channel after completion.

Appropriations for improving Norwalk Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 2, 1829	Survey	$80.00
Mar. 3, 1871	....do	1,166.66
June 10, 1872	Dredging (6 feet) above South Norwalk	10,000.00
Mar. 3, 1873	....do	10,000.00
June 23, 1874	....do	10,000.00
Mar. 3, 1875	Dredging (6 feet) below South Norwalk	7,000.00
June 18, 1878	....do	6,000.00
Mar. 3, 1879	Dredging (6 feet) above and below South Norwalk	10,000.00
June 14, 1880	Dredging (6 feet) below South Norwalk	5,000.00
Mar. 3, 1881	Dredging (8 feet) below and (6 feet) above South Norwalk	5,000.00
Aug. 2, 1882	Dredging (6 feet) above South Norwalk	5,000.00
July 5, 1884	Dredging (8 feet) below South Norwalk	5,000.00
Aug. 5, 1886	Dredging (6 feet) above South Norwalk	3,000.00
	Total	77,246.66

Norwalk is in the Fairfield collection district, and is about 11 miles west of Bridgeport, the port of entry. Norwalk light-house is on Sheffield's Island, at the harbor entrance. The nearest work of defense is Fort Schuyler, at the head of Long Island Sound, 29 miles southwest.

Money statement.

July 1, 1887, amount available	$560.04
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	56.94
July 1, 1888, balance available	503.10
Amount appropriated by act of August 11, 1888	28,000.00
Amount available for fiscal year ending June 30, 1889	28,503.10
Amount (estimated) required for completion of existing project	31,900.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	31,900.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR OF 1886.

Receipts	tons..	297,000
Shipments	do...	141,600
Vessels arriving and departing; draught 9 to 10 feet:		
Steamers	number..	1,269
Sail-vessels	do....	634
Barges	do....	467
Total		2,370

D 13.

IMPROVEMENT OF STAMFORD HARBOR, CONNECTICUT.

This is a small harbor on the north shore of Long Island Sound, about 6 miles east of the New York State line. The harbor consists of a bay about a mile long and a mile broad and of the mouth of Mill River, a small stream which is dammed at Oliver Street Bridge, at the head of the

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harbor. The original low-water depth for a mile below the bridge was from 1 to 3 feet in a crooked channel, and the 6-foot curve in the bay was about 6,600 feet below the bridge; the wharves are all in the upper half of this distance.

The mean rise of tides is 7.9 feet.

PROJECTS FOR IMPROVEMENT.

By act of March 2, 1829, Congress appropriated $100 for "making a survey of the harbor of Stamford, Conn., with a view to its improvement." The survey was made by Capt. Hartman Bache, U. S. Engineers, in 1829; in his report on the same, dated May 10, 1830, Captain Bache recommends excavating the channel, proposing to build a steam-dredge for the purpose, to cost—

For a channel 12 feet deep at ordinary high water (about 4 feet at mean low water)	$13,250.00
For a channel 10 feet deep at ordinary high water	11,035.20
Total	24,285.20

No money was appropriated for carrying out this plan.

The river and harbor bill of 1882 authorized a survey of this harbor, which was made in the following year. In his report on this survey, dated December 12, 1883, printed in Senate Ex. Doc. No. 50, Forty-eighth Congress, first session, also in the Annual Report of the Chief of Engineers for 1884, Part I, page 672, Colonel McFarland, U. S. Engineers, submitted a project for dredging a channel 80 feet wide and 5 feet deep at mean low water from deep water in the bay up to Oliver Street Bridge, estimated to cost as follows:

Dredging 80,000 cubic yards of mud, at 20 cents	$16,000
Contingencies	4,000
Total	20,000

It was not intended to include the removal of the ledge under and just below the bridge.

The beginning of work under this project was approved by the Secretary of War, August 30, 1886, after the first appropriation for improving the harbor had been made.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The contract with the Hartford Dredging Company, of Hartford, Conn., dated January 18, 1887, which was in progress at the date of my last annual report, was completed October 14, 1887. Since July 1, 1887, 30,846 cubic yards were dredged, which, with 23,616 cubic yards previously dredged, makes a total of 54,462 cubic yards under the contract.

The 5-foot channel was made 75 feet wide for more than one-half its projected length, and 50 feet wide the rest of the distance, except that at its lower end, where the mud is very soft and the depth but a few inches scant, it was dredged only 25 feet wide.

PRESENT CONDITION OF IMPROVEMENT.

The condition of the channel July 1, 1888, is as described above; this is the first public work of improvement done in Stamford Harbor.

PROPOSED OPERATIONS.

Future appropriations will be expended in accordance with the approved project; $10,000, the remainder of the total estimate, could be

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profitably expended during the next fiscal year in completing the project.

Appropriations for improving Stamford Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 2, 1829	Survey	$100
Aug. 2, 1882	do.	350
Aug. 5, 1886	Dredging	10,000
	Total	10,450

Stamford Harbor is in the Fairfield collection district, of which Bridgeport is the port of entry. There is a light-house on the middle ground at the harbor entrance. The nearest work of defense is Fort Schuyler, Throg's Neck, N. Y., 20 miles to the southwest.

Money statement.

July 1, 1887, amount available	$5,693.74
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	5,469.66
July 1, 1888, balance available	224.08
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,224.08
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract for improving Stamford Harbor, Connecticut, in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date of contract.	Subject of contract.	Price per cubic yard.
			Cents.
The Hartford Dredging Company, Hartford, Conn.*	January 18, 1887	Dredging	15.7

*Contract completed October 14, 1887.

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

	No.	Tonnage of cargoes.	Value of cargoes.
Vessels arrived	126	22,171	$162,559.50
Vessels departed	20	1,100	35,000.00

RECEIPTS.

	No. of cargoes.	Tons.	Value.
Coal	64	14,485	$74,957.50
Lumber	15	3,927	56,250.00
Miscellaneous	47	3,759	31,352.00

Maximum draft of vessels entering, 12 feet.

The above is only commerce by water and does not include what comes into town via "the canal"—a private channel; the latter is said to be twice as much as the above amounts. Probably much of it will come by way of Mill River when the channel is fairly opened.

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D 14.

IMPROVEMENT OF PORT CHESTER HARBOR, NEW YORK.

This harbor consists of the lower part of the Byram River, and a bay at its mouth opening into Long Island Sound. This river, for about 1½ miles from its mouth, forms the dividing line between the State of New York and Connecticut. It was formerly navigable to a point within a few hundred feet of the bridge at Port Chester, a little more than 1 mile from the mouth.

Before improvement, the depth below the wharves was in some places as little as 1 foot at mean low water. The mean rise of tide is 7.4 feet.

PROJECTS FOR IMPROVEMENT.

A survey of this harbor was made in 1871, and a project based on this was submitted and adopted. It provides for the removal of two rocks: Sunken Rock at the entrance to the bay, with 5.7 feet low-water depth, to be removed to 11 feet depth, and Salt Rock, about 1,000 feet above the mouth of the river, partly bare at low water, to be removed to 9 feet depth, also a breakwater 400 feet long at Byram Point. The estimated cost of the whole was as follows, viz:

Sunken Rock, 1,474.5 cubic yards, at $40	$58,980
Salt Rock, 316.3 cubic yards, at $40	12,652
Breakwater at Byram Point	25,000
Total	96,632

Under this project Salt Rock was removed in 1873. No further work was done until 1884, when a survey of the channel was made under the appropriation of August 2, 1882, and a project for expending the funds available in 1884 (about $16,000) based on this survey was submitted and approved. It provided for making a channel from 60 to 100 feet wide and 2½ feet deep at mean low water from the bay to the vicinity of the bridge at Port Chester. This modification was made in deference to the wishes of the business men of Port Chester. The channel was completed to within 150 feet of the bridge in May, 1885. A contract was entered into, May 15, 1886, with M. K. Pidgeon for the hire of the necessary plant for straightening and leveling the channel, and removing lumps left by the previous contractor both in the river and bay. This contract was completed July 22, 1886, 9,232 cubic yards of sand and gravel having been removed.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work has been done.

PRESENT CONDITION OF IMPROVEMENT.

Salt Rock has been effectually removed. No work has yet been done upon Sunken Rock, nor upon the breakwater at Byran Point.

An available channel 2½ feet deep at mean low water, and from 60 to 100 feet wide to a point 150 feet below the bridge, and 25 feet wide to the bridge, has been made, and the bottom in front of the wharves, where vessels have to lie at low tide, has been made as nearly level as possible.

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PROPOSED OPERATIONS.

Future appropriations will be applied to a continuation of the project. Appropriations for the improvement of Port Chester Harbor, New York, have been made as follows, viz:

Date.	Application.	Amount.
June 10, 1872	Removing Salt Rock	$12,000
Aug. 2, 1882	Dredging in Byram River and Bay	15,000
	Total	27,000

Port Chester Harbor is in the collection district of New York. The nearest lighthouse is on Great Captain's Island, 1¼ miles east of the month of the harbor. The nearest work of defense is at Throg's Neck, about 15 miles southwest.

Money statement.

July 1, 1887, amount available	$24.77
July 1, 1888, balance available	24.77
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,024.77
Amount (estimated) required for completion of existing project	64,632.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Kind.	Number.	Tonnage.
Steamers	314	54,170
Sailing-vessels	320	17,600
Barges, etc	590	118,250
Total	1,224	190,020

The draught of vessels trading at Port Chester ranges from 5 to 8 feet. Their tonnage ranges from 25 to 275 tons.

Cargoes.

	Tons.	Value.
Shipments	4,530	$283,050
Receipts	43,870	842,920
Total	48,400	1,125,970

The principal articles of commerce are manufactured goods, coal, iron, building materials, and general merchandise.

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D 15.

IMPROVEMENT OF MAMARONECK HARBOR, NEW YORK.

Mamaroneck Harbor, on the north shore of Long Island Sound, about 5 miles west of the Connecticut State line, consists of an open, shallow bay and a narrow tidal inlet about a mile long.

The channel to the old Steam-boat Wharf (about half-way up the inlet) had a depth of 5 feet at mean low water; from there to the upper wharves the depths gradually decreased to 1 foot. Near its mouth the inlet was obstructed by several rocks. The mean rise of tide at Mamaroneck is about 8 feet.

PROJECTS FOR IMPROVEMENT.

A survey of the harbor was made in 1881, and a project for improvement based on this survey was submitted and adopted, providing for the removal of Round Rock to a depth of 4 feet at mean low water, and five other rocks to a depth of 7 feet; for dredging a channel 7 feet deep and 100 feet wide from the Sound to the old Steam-boat Wharf, and thence 4 feet deep and 80 feet wide to the upper wharves, and for closing the small channel east of Grassy Knoll, at an estimated cost of $43,000. In 1881 Round Rock was removed to a depth of 4 feet, and Bush Rock and Inner Steam-boat Rock to 7 feet at mean low water, at a cost of $13,000, not including supervision and contingencies.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The available funds were not sufficient to continue work under the project.

PRESENT CONDITION OF IMPROVEMENT.

The available depth of channel has not changed since the original survey. The removal of three rocks has made the upper harbor much safer of access.

PROPOSED OPERATIONS.

It is proposed, when funds are appropriated for that purpose, to complete the existing project by removing the other dangerous rocks and by dredging in the channel. This could be completed to advantage in a single year.

Appropriations for improving Mamaroneck Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Survey	$500
Aug. 2, 1882	Removal of rocks	15,000
	Total	15,500

Mamaroneck Harbor is in the collection district of New York; its commerce is mainly of local importance. The nearest light-house is on Execution Rock, about 4 miles south; the fortifications at Throg's Neck, 9 miles southwest, are the nearest works of defense.

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Money statement.

July 1, 1887, amount available	$220.55
July 1, 1888, balance available	220.55
Amount (estimated) required for completion of existing project	28,000
Amount that can be profitably expended in fiscal year ending June 30, 1890	28,000

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Description.	Number.	Tonnage.
Steamers	92	13,800
Sailing-vessels	142	11,720
Barges, etc	124	21,700
Total	358	47,220

The draught of vessels trading at Mamaroneck ranges from 4½ to 6½ feet. Their tonnage ranges from 30 to 175 tons.

Cargoes.

	Tons.	Value.
Shipments	1,151	$23,087
Receipts	23,835	304,305
Total	24,986	327,392

The principal articles of commerce are coal, building materials, farm produce, and general merchandise.

D 16.

IMPROVEMENT OF ECHO HARBOR, NEW ROCHELLE, NEW YORK.

Echo Harbor is a bay on the north shore of Long Island Sound, distant about 22 miles by water from the Battery at New York. It is land-locked except toward the southeast, and has a good anchorage. Nearly all of the water transportation of the town of New Rochelle is carried on through this harbor.

The depth in the bay varies from 6 to 15 feet at mean low water, though the low-water channel up to the wharves is only from 1 to 2 feet deep.

The mean rise of tide is 7.3 feet.

PROJECT FOR IMPROVEMENT.

A survey was made in 1875, and a project based on it was submitted December 20, 1875, and subsequently adopted, providing for the removal of two rocky reefs from the channel, viz:

(1) Sheepshead Reef, lying midway between Echo Island and Duck Point, which had 1.6 feet of water upon it at low tide. This was to be removed to a depth of 9 feet at low water, which required the excavation of 872.5 cubic yards of rock, costing $21,201.75

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(2) Start Rock, which projected about 2 feet above low water, and lay in the channel 120 feet from Beaufort Point. This was to be removed to 7* feet below low water, requiring the excavation of 370 cubic yards of rock, costing	$12,672.50
Contingencies	5,081.13
Total	38,955.38

A depth of 7 feet over Start Rock was obtained in January, 1880, and in 1881–'83, 506 cubic yards were removed from the southern part of Sheepshead Reef, making 9 feet depth.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The money available was not enough to continue the projected work, and nothing was done.

PRESENT CONDITION OF IMPROVEMENT.

Start Rock has been removed to the required depth, 7 feet at mean low water, and about one-half of Sheepshead Reef has been removed to 9 feet depth. The condition of the channel is otherwise about the same as before the improvement, no other work having been done.

PROPOSED OPERATIONS.

With future appropriations the removal of Sheepshead Reef will be completed. Twenty-two thousand dollars have been appropriated for this project; with the balance of the estimate, $17,000, the project could be advantageously completed in a single year.

Appropriations for improving Echo Harbor, New Rochelle, N. Y., have been made as follows, viz:

Date.	Application.	Amount.
June 18, 1878	Removal of Start rock	$10,000
Mar. 3, 1879	....do	3,000
June 14, 1880	Removal of Sheepshead rock	3,000
Mar. 3, 1881	....do	3,000
Aug. 2, 1882	....do	3,000
	Total	22,000

Echo Harbor is in the collection district of New York. The nearest light-house is on Execution Rock. The fortifications at Throg's Neck, 7 miles to the westward, are nearest works of defense.

Money statement.

July 1, 1887, amount available	$3,043.97
July 1, 1888, balance available	3,043.97

Amount (estimated) required for completion of existing project	17,000
Amount that can be profitably expended in fiscal year ending June 30, 1890	17,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* A mistake in printing the original report made this depth 6 feet. This error has been copied in subsequent reports.

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COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Description.	Number.	Tonnage.
Steamers	276	22,080
Sailing vessels	154	10,500
Barges, etc	196	29,400
Total	626	61,980

Cargoes.

	Tons.	Value.
Shipments		
Receipts	38,900	$744,075
Total	38,900	744,075

The principal articles of commerce are coal, building materials, and general merchandise.

D 17.

IMPROVEMENT OF NEW ROCHELLE HARBOR, NEW YORK.

New Rochelle Harbor is situated at the western end of Long Island Sound, on its north shore, about 10 miles west of the boundary line between the States of New York and Connecticut. The harbor lies off the southerly part of the town of New Rochelle, and Echo Harbor is off the northerly part.

New Rochelle Harbor consists of rather narrow and circuitous passages between several rocky islands and reefs, which shelter it from rough weather. It had originally an available depth of 8 to 9 feet at mean low water; there were two rocks near the channel-way whose removal was desired, and the narrowness of the deep-water channel made it difficult for vessels to turn.

PROJECTS FOR IMPROVEMENT.

A survey of New Rochelle Harbor was ordered by the act approved June 14, 1880, and made in the same year. In the report of this survey, January 28, 1881, a project for improvement was submitted, contemplating the removal of Corning Rock to 12 feet depth at mean low water, of Rock C to 9 feet depth, the dredging of a channel 100 feet wide and 8 feet deep around the south end of Glen Island to connect with the channel around the north end of that island, and the removal of a reef that obstructed the entrance to this dredged channel, the whole being estimated to cost $40,825. The object of this dredging and rock removal was to allow vessels to pass around the island, instead of having to turn in the narrow channel.

In 1881 the channel around Glen Island was dredged 100 feet wide and 6 feet deep, and work was begun under a contract to remove the reef at the channel entrance to 8 feet depth.

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The contract was extended, and in 1883 work was abandoned by the contractor while parts of the rock were still from 1 to 1½ feet above the plane of removal.

In 1883 Corning Rock was removed to 11 feet depth by hired labor, at a cost of about $34 per cubic yard; a large bowlder was removed from near David's Island Wharf, and 10.6 cubic yards of loose rock were removed from the reef at the entrance to the dredged channel, making a depth of 7.5 feet there.

An examination of the dredged channel and the rocks at the entrance was made in April, 1887. By this examination, a reef was discovered, not shown on the original survey, projecting about 40 feet into the proposed channel, with a least depth of 6 feet; also a rock, known as Rock B, projecting about 10 feet into the proposed channel, with a least depth of 29 feet. Authority was obtained, under date of April 30, 1887, to complete the removal of the rocks at the entrance by hired labor, and to deepen the dredged channel to 8 feet at mean low water by contract.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Under authority from the Chief of Engineers, dated July 13, 1887, the steam drilling-plant belonging to the improvement of the Raritan River, New Jersey, was put in repair, the expense being borne equally by the appropriation for improving the Raritan River and that for New Rochelle Harbor. With this plant, the removal of the rocks at the entrance to New Rochelle Harbor by hired labor was begun September 27, 1887, and continued until November 30, 1887, when the work was closed for the season. The work was resumed May 2, 1888, and completed May 31, 1888. Thirty-seven and ninety-two hundredths cubic yards of rock, measured in place, were removed from Rock B, making 8 feet depth at mean low water; 180.63 cubic yards of rock were removed from the large rock discovered by the above-mentioned examination, giving a minimum depth of 75 feet.

PRESENT CONDITION OF IMPROVEMENT.

A channel 100 feet wide, and with a mimimum depth of 7.5 at mean low water, has been made through the rocks at the entrance. The dredged channel has nearly retained its depth of 6 feet at mean low water. No work has yet been done on Rock C.

PROPOSED OPERATIONS.

It is proposed to expend the funds now available in widening and deepening the channel between Glen Island and the main land by dredging.

Appropriations for the improvement of New Rochelle Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Dredging and partial removal of rock at mouth of Glen Island Channel	$20,000
Aug. 2, 1882	Removing Corning Rock	15,000
	Total	35,000

New Rochelle Harbor is in the collection district of New York. The nearest lighthouse is on Execution Rock. The fortications at Throg's Neck, 7 miles west, are the nearest works of defense.

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Money statement.

July 1, 1887, amount available		$16,843.66
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$7,518.69	
July 1, 1888, outstanding liabilities	190.00	
		7,708.69
July 1, 1888, balance available		9,134.97

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Kind.	Number.	Tonnage.
Steamers	3,358	1,265,400
Sailing vessels	8	1,250
Barges, etc	580	443,900
Total	3,946	1,710,550

The draught of vessels trading at New Rochelle Harbor ranges from 5 to 9 feet. Their tonnage ranges from 25 to 950 tons.

Cargoes.—Receipts: tons, 10,850; value, $98,040. The principal articles of commerce are building materials and general merchandise. Over 700,000 passengers were brought into the harbor during the year.

D 18.

IMPROVEMENT OF EAST CHESTER CREEK, NEW YORK.

East Chester Creek is a small tidal stream emptying into East Chester or Pelham Bay. The bay is on the north side of Long Island Sound, at its western end, being just east of Throg's Neck, and 20 miles by water from the Battery at New York.

The mean rise of tide is 7.1 feet.

A reef of bowlders close to the course of vessels passing through the draw of Pelham Bridge (near the mouth of the creek), made the entrance dangerous.

The available depth of Town Dock, 1½ miles from the mouth, was, at high water, rather over 7 feet. About the same depth could be carried to Lockwood's, 2¼ miles from the mouth.

PROJECTS FOR IMPROVEMENT.

The amount heretofore reported in the annual reports as the original estimates, viz, $136,500, was for a partial project for an improvement from Town Dock to a point 3,000 feet above Lockwood's, submitted in 1872. (Annual Report of Chief of Engineers for 1881, page 640.)

In 1875, the project was modified by changing the location of the cut from Lockwood's to Town Dock, involving rock excavation, at an additional cost of $10,000. (Letters from General Newton, dated September 24, 1875, and letter from the Chief of Engineers, dated September 28, 1875.)

Since then, up to 1884, additional projects have been made and partially carried out for improvement below Town Dock at an actual cost of $22,600, and an additional estimated cost of $52,000. The original

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estimate and the amounts required for completion of existing project should, therefore, be increased by $84,600.

The entire project thus far adopted consists of excavating a channel 9 feet deep at mean high water from Pelham Bridge to a point about 3,000 feet above Lockwood's, by removing bowlders and gravel from near the draw of Pelham Bridge; by dredging a channel west of Goose Island, 125 feet wide and 1,500 feet long; and by dredging a cut 100 feet wide and about 3,000 feet long, from Pell Point to the first bend above Town Dock, and thence extending it by an easy curve through a marsh and some rock cutting to Lockwood's, a stretch in which the natural bed of the stream was very winding; a cut 3,000 feet long, 100 feet wide, and 9 feet deep, was to be made above Lockwood's to serve both as a channel and tidal basin; the channel was also to be confined in certain parts by timber dikes having an aggregate length of 5,800 feet. The estimated cost of the whole is $221,100.

The first work under this project was done in 1877. Since that time the channel through the marsh and rock just below Lockwood's has been made 100 feet wide and 9 feet deep at mean high water; the channel west of Goose Island has been dredged 125 feet wide and 9 feet deep at mean high water; the bowlders in the vicinity of Pelham Bridge draw have been removed; the channel just above and under the new draw-bridge on the Boston road at Lockwood's has been dredged out; a channel about 2,000 feet long and 9 feet deep at mean high water has been dredged from Pell Point up to Town Dock, the width being 40 to 45 feet, gradually increasing to 90 feet at Town Dock, and 1,235 linear feet of diking have been built.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

A contract was entered into, July 11, 1887, with the Frank Pidgeon Dredging Company of New York, for the removal of about 30,000 cubic yards of mud measured in scows, the work to be applied to widening the channel and removing shoal spots. This contract was annulled by authority of the Chief of Engineers, dated August 18, 1887, on account of the contractor's failure to begin work within the time required. An examination of the channel made in September, 1887, showed the existence of a channel 100 feet wide and 9 feet deep at mean high water from the bay to Town Dock; from Town Dock to Lockwood's there was an available depth of about 8 feet at mean high water, in a narrow channel. Advertisement was made, proposals opened April 21, 1888, and a contract entered into May 11, 1888, with the Hartford Dredging Company, of Hartford, Conn., for the removal of 1,700 cubic yards of mud measured in scows. Work was begun under this contract June 7, 1888, and up to June 30, 1888, 1,772 cubic yards had been removed near Town Dock.

PRESENT CONDITION OF IMPROVEMENTS.

There is a channel, 100 feet wide and 9 feet deep at mean high water, from the bay to Town Dock; and a narrow channel, 8 feet deep at mean high water, from Town Dock to Lockwood's. Above that no work has been done.

PROPOSED OPERATIONS.

Work will be continued under the contract with the Hartford Dredging Company. Future appropriations will be applied to completing and maintaining the channel as projected.

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Appropriations for improving East Chester Creek have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1873	Cutting through marsh and rock, and diking (in 1877)	$25,000
Mar. 3, 1875	Dredging under Boston Road Bridge and at Goose Island	12,000
June 18, 1878	Dredging near Lockwood's, Goose Island, and Pelham Bridge	10,000
Mar. 3, 1879 / June 14, 1880	Dredging 40 to 90 feet wide from Pell Point to Town Dock	3,500 / 3,500
Aug. 5, 1886	Dredging above Town Dock (not yet expended)	10,000
	Total	64,000

East Chester Creek is in the collection district of New York. The nearest lighthouse is on the Stepping Stones, 3 miles southeast of the mouth of the creek. The nearest work of defense is Fort Schuyler, Throg's Neck, about 3½ miles south.

Money statement.

July 1, 1887, amount available		$9,673.78
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,256.18	
July 1, 1888, outstanding liabilities	797.40	
July 1, 1888, amount covered by existing contracts	6,852.60	
		8,906.18
July 1, 1888, balance available		767.60
Amount appropriated by act of August 11, 1888		5,000.00
Amount available for fiscal year ending June 30, 1889		5,767.60
Amount (estimated) required for completion of existing project		152,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for dredging in East Chester Creek, New York, opened at Engineer Office, U. S. Army, New York, April 21, 1888.

No.	Name and address of bidder.	Rate per cubic yard.	Remarks.
		Cents.	
1	James McSpirit, Jersey City, N. J.	47½	Only one guarantor.
*2	Hartford Dredging Company, Hartford, Conn	45	
3	Michael H. Flannery, New York City	45	

*Contract awarded to the Hartford Dredging Company.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Kind.	Number.	Tonnage.
Sailing vessels	8	360
Barges, etc	90	15,750
Total	98	16,110

The draught of vessels trading in East Chester Creek ranges from 5 to 7½ feet. Their tonnage ranges from 30 to 200 tons.

Cargoes.—Receipts, 10,625 tons; value $61,075.

The principal articles of commerce are coal and building materials.

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D 19.

IMPROVEMENT OF GREENPORT HARBOR, NEW YORK.

This harbor is a roadstead near the east end of the north fork of Long Island, lying between this north fork on the northwest and north and Shelter Island on the southeast and south. The anchorage-ground is exposed to storms from the northeast and east.

A sand-spit called Joshua's Point, formerly protected the little bay at Greenport from easterly storms, but in the few years prior to 1883 this had worn away rapidly, and the sand had been carried out into the bay.

The mean rise of the tide is 2.4 feet.

PROJECT FOR IMPROVEMENT.

In 1881 a survey was made, and, with the report, a plan and estimates based upon the survey were submitted, and subsequently adopted, for a breakwater extending southeasterly from Joshua's Point. This project consisted of a riprap breakwater about 1,700 feet long extending from high-water mark to the 18 foot curve, to be built 3 feet above mean high-water level with a top width of 5 feet, and side slopes of 1 on 1, to contain about 23,000 tons of stone. Its estimated cost was $46,000. Work under this project was begun in 1883, and in that and the two following years 1,233 linear feet of the breakwater were built. Under the appropriation of August 5, 1886, a contract was entered into with James V. Luce, of Niantic, Conn., on October 27, 1886, for delivering 3,400 tons of stone on the breakwater. Work was begun May 18, 1887, and, up to June 30 of that year, 1,596 tons of stone had been delivered, extending the breakwater 92 feet.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Work under the above contract was continued and completed, extending the breakwater 204 feet, giving it a total length of 1,437 feet, and carrying it into 15.4 feet depth at mean low water; 14,775¼ tons of riprap granite have thus far been used in its construction.

PRESENT CONDITION OF IMPROVEMENT.

The breakwater is in good condition as far as completed. No material changes of depth in the harbor have occurred since the original survey.

PROPOSED OPERATIONS.

With further appropriations the breakwater will be completed as projected to the 18-foot curve. Twenty-five thousand dollars have been appropriated for this work. The remainder of the estimate, $21,000, could be profitably expended in completing the breakwater in one year.

Appropriations for improving Greenport Harbor have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1881	Survey	$500
Aug. 2, 1882	Expended on breakwater	10,000
July 5, 1884	....do	10,000
Aug 5, 1886	....do	5,000
	Total	25,500

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Greenport is a port of delivery in the collection district of Sag Harbor. The nearest light-house is on Long Beach Point, 3 miles to the eastward. The nearest work of defense is Fort Trumbull, New London Harbor, Connecticut, 21 miles distant in a straight line.

Money statement.

July 1, 1887, amount available	$2,957.93
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,917.83
July 1, 1888, balance available	40.10
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,040.10
Amount (estimated) required for completion of existing project	16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	16,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Description.	Number.	Tons.
Steamers	2,240	421,000
Sailing vessels	1,080	195,750
Barges, etc	16	7,200
Total	3,936	623,950

Cargoes.

	Tons.	Value.
Shipments	10,500	$300,500
Receipts	33,070	1,138,500
Total	43,570	1,439,000

The principal articles of commerce are coal, building materials, farm produce, and general merchandise.

D 20.

IMPROVEMENT OF PORT JEFFERSON HARBOR, NEW YORK.

This harbor is a large landlocked bay on the north side of Long Island, about 60 miles east of New York in a direct line, and nearly opposite Bridgeport, Conn. Its high-water area, with that of its shallow tributaries, Setauket Harbor and Conscience Bay, is about 2½ square miles, and the width of the outlet is but 450 feet. Port Jefferson lies at the head of the harbor, nearly 2 miles from the outlet, and there is a depth of 12 feet or more at low water to within 300 feet of the wharves over nearly the whole width of the harbor. Originally there was a bar just outside the outlet, with a depth of 3 feet at mean low water, over which the tide ebbed and flowed very rapidly.

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PROJECTS FOR IMPROVEMENTS.

A survey of the harbor was made in 1853 by Lieutenant Harrison, U. S. Engineers. In 1870 an examination was ordered by Congress. The first project for improvement was submitted by General Warren, January 16, 1871, after an examination, and provided for building a jetty on the east side of the entrance, extending out to the 9-foot curve, and rising to 11 feet above mean low water, to be built partly of dimension stone; also for dredging a channel 200 feet wide and 7 feet deep at mean low water through the bar. The estimated cost was as follows, viz:

Construction of jetty	$150,125
Dredging	15,000
Total	165,125

When the project was adopted, under the appropriation of March 3, 1871, it was provided that the jetty should be of riprap, rising only to the level of mean high water, except between the high and low water marks on the beach, where it was to be carried to the level of the highest tides; but no change was made in the estimates. Under this appropriation 600 feet of the jetty were built; and under the appropriation of June 10, 1872, it was extended to 1,052 feet. An estimate made in 1873 of the cost of completion ($35,000) makes the estimate for the whole project $65,000. In 1875 a modification of the project, based on the observed effect of the jetty, was made, providing for a jetty on the west side of the entrance, about 1,075 feet long, and rising 4 feet above mean high water, designed to increase the force of the tidal currents; the width of the channel was also reduced to 100 feet. No new estimate was submitted at the time; but in 1877, after about $8,000 had been expended on the west jetty, it was estimated that $12,250 would be required to complete it, or $20,250 in all. A revised estimate, made in the same year, for the whole improvement, contemplated extending the east jetty to the 9-foot curve, extending the west jetty 600 feet farther, and dredging a channel 100 feet wide and 8 feet deep (this increase of depth on account of increased draught of vessels using the harbor), at an estimated cost of $34,000; $45,000 had then been appropriated and nearly expended, making the total estimate from the beginning $79,000 (including $6,000 appropriated in 1876, and then unexpended). This estimate was incorrectly reported in 1878, but reverted to in 1879, and repeated in each subsequent annual report. In 1877 one cut 25 feet wide and 8 feet deep was dredged through the bar. The channel was dredged to a width of 100 feet under the appropriation of March 3, 1879. In 1877 the east jetty was raised to a height of 5 feet above mean high water, and extended 50 feet. In 1878 the west jetty was extended 450 feet, but the height was made only 2 feet above mean low water, except the outer end and an intermediate point, which were raised to 4 feet above mean high water, to serve as guides.

Between 1879 and 1883 both jetties were extended and repaired, making their respective lengths 1,390 feet for the east jetty and 940 feet for the west.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

No work was done.

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PRESENT CONDITION OF THE IMPROVEMENT.

The east jetty is 1,390 feet long, terminating in 10 feet of water. The west jetty is 940 feet long, terminating in 6.5 feet of water. The dredged channel retains nearly its depth of 8 feet at mean low water.

PROPOSED OPERATIONS.

The amount estimated for the completion of the project was reached by the appropriation made August 2, 1882, and the project itself is completed. Whether the depth gained will be permanent or not can only be told by time. No further operations are proposed at present.

Appropriations for improving Port Jefferson Harbor, New York, have been made as follows, viz:

Date.	Application.	Amount.
Mar. 3, 1871	East jetty	$15,000
June 10, 1872	....do	15,000
Mar. 3, 1875	East and west jetties	15,000
Aug. 14, 1876	East jetty and dredging	6,000
June 18, 1878	East and west jetties	8,000
Mar. 3, 1879	Dredging	5,000
June 14, 1880	East and west jetties	3,000
Mar. 3, 1881	East jetty	4,000
Aug. 2, 1882	....do	8,000
	Total	79,000

Port Jefferson is a port of delivery in the collection district of New York. There is a light-house on Old Field Point, 1¼ miles west of the harbor entrance. Fort Hale, New Haven Harbor, Connecticut, 23 miles distant, is the nearest work of defense.

Money statement.

July 1, 1887, amount available	$374.76
July 1, 1888, balance available	374.76

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Description.	Number.	Tons.
Steamers	786	106,100
Sailing vessels	556	35,870
Barges, etc	.....	.....
Total	1,342	141,970

The draught of vessels trading at Port Jefferson ranges from 5 to 14 feet. Their tonnage ranges from 25 to 500 tons.

Cargoes.

	Tons.	Value.
Shipments	3,235	$49,350
Receipts	23,260	373,650
Total	26,495	423,000

The principal articles of commerce are coal, building materials, farm produce, and general merchandise.

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D 21.

IMPROVEMENT OF FLUSHING BAY, NEW YORK.

Flushing Bay is on the north shore of Long Island, about 14 miles by water from the Battery at New York. The town of Flushing is on the east bank of Flushing Creek, a quarter of a mile from the head of the bay. The bay is about 1 mile wide and 2 miles long; the bottom is of soft mud, nearly level, the depth in the original channel being not much greater than elsewhere. In 1861 there was a depth of 5 feet at low water in the channel leading up to Flushing, and in 1879 but 3.9 feet.

The mean rise of tide is 7.1 feet.

PROJECT FOR IMPROVEMENT.

A survey of Flushing Bay was made in 1878, and a project for improvement, based on it, was proposed and adopted, providing for the construction of a dike extending across the westerly part of the mouth of the bay and upon the west side of the channel to the head of the bay near Flushing, and a dike extending from a point near the middle of the east shore in a northerly direction to the 6-foot curve and almost parallel to the first, in order to form a large tidal basin whose waters should ebb and flow through a narrow channel, with dredging to maintain a channel 6 feet deep at mean low water. The estimated cost for carrying out this project was as follows:

Constructing 4,400 linear feet of pile-dike, at $10 per foot	$44,000
Constructing 7,800 linear feet of pile-dike, at $9 per foot	70,200
Constructing 900 linear feet of pile-dike, at $7.50 per foot	6,750
Constructing 3,600 linear feet of single piling, at $3.70 per foot	13,320
For 83,000 cubic yards of dredging, at 20 cents per cubic yard	16,600
Contingencies	22,630
Total	173,500

All the timber work of the dikes was to be creosoted. Up to June 30, 1880, 3,057 linear feet of pile-dike were constructed on the west side of the channel from the head of the bay. Subsequent appropriations have been expended in dredging.

Under the appropriation of August 5, 1886, a contract was entered into, October 23, 1886, with P. Sanford Ross, of Jersey City, N. J., for the removal of 45,000 cubic yards of mud measured in scows. The dredging was to be applied to widening the channel and removing shoal places in the channel already dredged. Work was begun under this contract May 16, 1887, and up to June 30, 1887, 23,630 cubic yards of mud had been removed.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

Work was continued under the contract with P. Sanford Ross and completed July 28, 1887. All shoal spots in the channel were removed, the 6-foot channel widened to 170 feet both along and northward of the dike and along the wharves at Flushing, and to 200 feet from deep water in the bay to a point 500 feet south of the north end of the dike a distance of 2,400 feet. A branch channel 1,450 feet long and 55 feet wide was also dug from near the south end of the dike to the steam-boat landing on the south end of the bay, and a turning basin 90 feet square at the steam-boat landing. An examination of the dredged channel was

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made in June, 1888. It showed that the main channel had still an available depth of nearly 6 feet, but that the branch channel had shoaled considerably.

PRESENT CONDITION OF IMPROVEMENT.

Of the proposed 16,700 linear feet of dike 3,057 have been built. The channel leading up the bay to the wharves has been three times dredged. The examination of June, 1888, shows that it has an available depth of nearly 6 feet.

PROPOSED OPERATIONS.

Until the dikes are completed dredging will be needed frequently, probably annually, to maintain the channel. If appropriations are made more than is urgently needed for dredging it is proposed to continue the construction of dikes as provided for in the project.

Appropriations for improving Flushing Bay, New York, have been made as follows:

Date.	Application.	Amount.
Mar. 3, 1879	Construction of dike	$20,000
June 14, 1880	Dredging	15,000
Mar. 3, 1881	do	10,000
Aug. 2, 1882	do	5,000
July 5, 1884	do	10,000
Aug. 5, 1886	do	10,000
	Total	70,000

Flushing Bay is in the collection district of New York. The nearest light-house is on North Brother Island. Fort Schuyler, New York Harbor, is the nearest work of defense.

Money statement.

July 1, 1887, amount available	$5,201.38
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,181.12
July 1, 1888, balance available	1,020.26
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	16,020.26
Amount (estimated) required for completion of existing project	88,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels.

Kind.	Number.	Tonnage.
Steamers	755	115,600
Sailing vessels	864	43,200
Barges, etc	732	182,600
Total	2,351	341,400

The draught of vessels trading at Flushing ranges from 5 to 9 feet. Their tonnage ranges from 20 to 300 tons.

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Cargoes.

	Tons.	Value.
Shipments	135 475	$3, 152, 400
Receipts	93, 760	2, 502, 425
Total	229, 235	5, 654, 825

The principal articles of commerce are manufactured goods, coal, grain, building materials, and general merchandise.

D 22.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTION OR ENDANGERING NAVIGATION.

WRECK IN THE CONNECTICUT RIVER AT HARTFORD, CONNECTICUT.

The sloop scow *George C. Bloomer*, owned by Elizur Smith, of Hartford, Conn., sunk about five years ago on the east side of the channel opposite Hartford. In 1886 she was reported as an obstruction to navigation; her deck and cabin had been carried away by ice, her hull had filled with sand, and a bar was forming below the wreck with from 1 to 3 feet of water where the depth had been 6 feet.

The contract with William E. Chapman, of Brooklyn, N. Y., to remove this wreck, which was in force at the date of the last Annual Report, was completed August 16, 1887. Work was done by pumping out sand and placing chains under the wreck to remove it bodily; while lifting on the chains the wreck broke, and subsequently the greater part of it was removed by grappling; the pieces left were splinters too small to injure vessels if struck by them. A report to the Chief of Engineers, dated October 10, 1887, gives details of the removal.

Abstract of contract for removing wreck in the Connecticut River, at Hartford, Conn., in force during the fiscal year ending June 30, 1888.

Name and address of contractor.	Date.	Price.
William E. Chapman, Brooklyn, N. Y*	November 6, 1886	$599

*Contract completed August 16, 1887.

WRECK IN THE CONNECTICUT RIVER AT SAYBROOK POINT, CONNECTICUT.

February 8, 1887, the schooner *R. H. Daly*, —— Crowley, captain and owner, employed by the contractor for delivering stone on the Saybrook jetties, sunk while loaded, and lay in about 30 feet of water near the west side of the channel at the mouth of South Cove, and about 3,000 feet north of the light-house on Lyndis Point. In April, 1887, the owner made an unsuccessful attempt to raise her; he removed such of her spars as could easily be detached, and abandoned her.

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Authority for her removal was granted, and the notice to owners, as required by law, was published May 13, 1887.

July 13, 1887, Mr. C. C. Goodrich, of Hartford, Conn., made an offer to remove this wreck for the sum of $500; it was considered most economical and advantageous to the Government to accept this offer, which was done with approval of the Chief of Engineers. Mr. Goodrich completed the removal of this wreck December 16, 1887; 230 pounds of dynamite were exploded under her, completely shattering her hull, so that a final examination by sweeping discovered no part of the wreck above the surrounding bottom.

WRECK ON THE WEST END OF LONG SAND SHOAL, LONG ISLAND SOUND.

In November, 1885, the *Louise Bliss*, a three-masted schooner, said to be about 120 feet long, was wrecked and sunk near the west end of Long Sand (or Cornfield) Shoal, about 6 miles southwest from the mouth of the Connecticut River, and on the south side of the shoal. When wrecked, she was bound east with a cargo of about 700 tons of coal; most of the coal was removed from her within a few months.

This wreck was first reported as endangering navigation in the summer of 1887, and August 8, 1887, a petition for its removal, signed by several transportation companies doing business in Long Island Sound, was forwarded to the Chief of Engineers, with a letter from the inspector of the third light-house district, advising such removal; authority for such action was granted by the Secretary of War, August 15, 1887.

At this time the wreck lay in about 3 fathoms of water, and her hull stood 9 feet above the bottom; one timber, supposed to be the stem, was just visible at low water.

The notice to owners, as required by law, was published August 22, 1887, and proposals for removal of wreck were opened November 23, 1887; under date of December 7, 1887, a contract for doing the work for the sum of $1,745 was entered into with Johnston & Maull, of Lewes, Del. Work was begun at once, and completed December 15; 365 pounds of dynamite were exploded under and upon the wreck, which shattered it completely, and a final examination showed no part of it remaining above or upon the bottom.

Abstract of proposals for removing wreck at Cornfield Shoal, opened at Engineer Office, U. S. Army, New York City, November 23, 1887.

No.	Names and addresses of bidders.	Amount of bid.	Remarks.
1	George W. Townsend, Boston, Mass	$2,479	By blasting.
*2	Chas. W. Johnston and Franklin C. Maull, Lewes, Del	1,745	By blasting.
3	Atlantic Dredging Company, Brooklyn, N. Y	1,880	By blasting and grappling.
4	William E. Chapman, New York City	2,289	By blasting and use of steam-derrick.

* Entered into contract December 7, 1887; contract completed December 15, 1887.

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WRECK IN LONG ISLAND SOUND, SOUTHWEST FROM BLACK ROCK HARBOR, CONNECTICUT.

In a letter dated July 30, 1887, the collector of port at Bridgeport, Conn., reported to the Secretary of War that a wreck lying southwest from Black Rock Harbor, Connecticut, was in a very dangerous position. This was referred to me, and August 8, 1887, it was returned with indorsement and three inclosures showing that the wreck was the schooner *Emma J. Higgins*, sunk by collision, April 14, 1887, and then lying in about 11 fathoms of water; that her spars were standing at or near the surface and were obstructions dangerous to navigation, such as contemplated by section 4 of the river and harbor act of June 14, 1880.

Her removal was authorized by the Secretary of War, August 12, 1887, and under date of August 20 the required notice to owners was published. About this time the spars were broken off at about low-water level, and as the wreck lay between 3 and 4 miles from shore it was difficult to fix its precise location; this was determined early in December, 1887, and an offer of Capt. John McNeil, of the Bridgeport Towing Line, to remove so much of the spars and rigging as was necessary to make a clear depth of 25 feet at low water for the sum of $200 was recommended for acceptance as being most economical and advantageous to the Government. The recommendation was approved by the Secretary of War, December 17, 1887.

January 4, 1888, the work was done, a spar 58 feet long with part of the hull attached being pulled out by a tug-boat. Unfavorable weather delayed making an examination sufficient to determine with certainty whether the work was completed until April 17, 1888, when the wreck was carefully swept and sounded, and nothing discovered at less than 39 feet depth below low water.

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APPENDIX E.

IMPROVEMENT OF HUDSON RIVER AND OF HARBORS OF RONDOUT AND SAUGERTIES, NEW YORK—REMOVING OBSTRUCTIONS IN EAST RIVER AND HELL GATE—IMPROVEMENT OF ENTRANCE TO NEW YORK HARBOR—IMPROVEMENT OF RIVERS AND HARBORS IN THE VICINITY OF NEW YORK AND IN NORTHERN NEW JERSEY.

REPORT OF LIEUTENANT-COLONEL WALTER McFARLAND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Hudson River, New York.
2. Harbor of Saugerties, New York,
3. Harbor at Rondout, New York.
4. Harlem River, New York.
5. Removing obstructions in the East River and at Hell Gate, New York.
6. Newtown Creek, New York.
7. Buttermilk Channel, New York.
8. Gowanus Bay, New York.
9. New York Harbor.
10. Sheepshead Bay, New York.
11. Canarsie Bay, New York.
12. Sumpawanus Inlet, New York.
13. Channel between Staten Island and New Jersey.
14. Raritan Bay, New Jersey.
15. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEY.

16. Spring Creek, New York.
17. Hudson River, New York, between New Baltimore and Coxsackie.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., July 24, 1888.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1888, upon the works of river and harbor improvement under the charge of the late Lieut. Col. Walter McFarland, Corps of Engineers.

These reports were completed and revised by Colonel McFarland personally, within a few days of his death.

The works were in temporary charge of Lieut. Col. G. L. Gillespie from January 1, 1888, to June 29, 1888.

Very respectfully, your obedient servant,

GEO. McC. DERBY,
Captain of Engineers, in temporary charge.

The CHIEF OF ENGINEERS, U. S. A.

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E 1.

IMPROVEMENT OF THE HUDSON RIVER, NEW YORK.

My annual report for 1885 contained a history of this improvement, accompanied by original reports and two sketches showing its condition at that time. This may be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 677.

The only part of the Hudson River which has been improved by the General Government is the stretch about 20 miles long, beginning at the head of navigation at Troy, N. Y., about 6 miles above Albany, and extending down the river to New Baltimore, about 14 miles below Albany.

While there has always been enough water below New Baltimore for navigation this upper section of the river, so far as its history is known to us, has always been obstructed by bars and shoals due to the existence of numerous islands and sloughs, and the consequent diversion of the river water through too many channels.

Prior to 1831, when the jurisdiction of the Federal Government over these waters was confirmed by judicial decision, the State of New York had made efforts to improve the navigation of this part of the river. Since 1831 the improvement of the Hudson River has been conducted both by the State of New York and by the General Government, both building and repairing dikes and doing such dredging as seemed necessary. In the last few years, however, the dike work has been left almost exclusively to the General Government, while the State of New York has done most of the dredging required.

The general system of improvement has been the same throughout, viz, the contraction of the channels by the construction of jetties and dikes intended to deepen them by means of the scour so produced, and also deepening by dredging where it could not be dispensed with.

But up to 1831 the work, which had consisted almost entirely of the construction of spur-dikes and of dredging, had produced very little permanent improvement.

After 1831, however, the United States began the present general system of improvement, which consists of contracting the channel by means of longitudinal dikes, intended to aid in scouring the bars and shoals, instead of using spur jetties, as had been done previously.

Under this system the United States constructed two dikes in 1835, 1836, 1837, and 1838.

Then followed a long interval of time in which nothing was done by the United States, except in 1852; but in 1863 the State of New York took up the improvement on the general plan adopted by the United States in 1831, viz, substituting a system of longitudinal dikes instead of the jetty system, and between 1863 and 1867, built six important longitudinal dikes of this kind. (Annual Report of 1885, page 678.)

The work was taken up again by the United States in 1864, when, out of the general sum appropriated for river and harbor improvements, $33,000 were allotted for the Hudson River improvement, and this was followed by the act of June 23, 1866, which appropriated $50,000 for the same work. Lieutenant-Colonel, now General, John Newton, Corps of Engineers, was placed in charge of this improvement, and remained in charge of it eighteen years; that is, until April 1, 1884.

In November, 1866, General Newton submitted a project for the improvement of the 20 miles of river between New Baltimore and Troy, which may be found in the Annual Report of the Chief of Engineers for

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1885, part 1, page 678; and based upon this report a systematic improvement of the river was begun and has been continued up to the present time.

His project was to secure a navigable channel 11 feet deep at mean low water from New Baltimore up to Albany, and 9 feet deep at mean low water from Albany up to Troy.

The estimated cost of this improvement was $862,297.75; but after more reliable data had been obtained in 1866 and 1867, a second estimate was made, increasing the estimate $122,006.72, making the total estimated cost $984,304.47.

This estimate was again increased in 1882 by $78,000 for the completion of existing works, a large amount of the appropriation intended for construction having been spent on repairs; and again in 1884 by $16,000, for the removal of a hitherto unknown rock in the Overslaugh Channel at Van Wie's Point, which brought the total estimate up to $1,078,304.47, although the amounts given in the Annual Reports as the estimated cost of the improvement, from 1868 to 1881, have been erroneously printed $984,304.47, and from 1882 to 1886 as $1,062,304.47.

Of this amount $1,027,288 had been appropriated up to June 30, 1885, when the available channel depth between New Baltimore and Albany was 10 feet, except at one point, Beacon Island, where there was a depth of 8.8 feet; and 8 feet could be carried from Albany to Troy, except at Coville's Folly and Patroon's Island, where there were 7.8 and 7.5 feet, respectively, at low water.

These bars were subsequently dredged by the State of New York, but others have since been formed yearly by ice gorges.

The gradual and steady increase in the navigable depths obtained during the improvement of the Hudson River are very marked.

In 1819 the available channel between New Baltimore and Albany was 4 feet at mean low water; in 1867 it was 7½ feet; in 1878 and 1879 it was 8½; in 1885, 10 feet, except at the spot mentioned, which was subsequently dredged by the State. A table showing the depths from 1819 to 1879 may be found on page 691, Annual Report of the Chief of Engineers for 1885.

The act of Congress approved August 5, 1886, appropriated $26,250 for this improvement, making, with the old balance on hand, $54,768.40 available at that date.

The condition of the dikes was so bad that it was found necessary to apply all this to repairs and not to the construction of further permanent works.

The permanent works remaining to be built, in order to complete the improvement as originally projected, are:

1. Completion of dike from Staat's Island to Campbell's Island Dike.
2. Completion of dike from Schermerhorn to Shad Island.
3. The proposed improvement between Shad Island and Mull's Plaat.
4. The improvement at Willow Island.
5. The construction of a new dike below Nine Mile Tree.
6. The extension of the dike at Mull's Plaat.
7. The removal of the Overslaugh Rock at Van Wie's Point.

The first of these six items were, under the estimate of 1882, to cost $78,000, and the seventh item, under the estimate of 1884, was to cost $16,000; making the total amount needed for completing the original project $94,000.

The actual cost, however, will exceed this amount, as the cost for completing the dike from Staat's to Campbell's Island will exceed the estimate, since the three detached sections of this dike, which were built along the proposed line in 1879, have been completely broken by

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the action of the ice, and an entirely new and stronger dike, consisting of two rows of piles filled in with stone, will have to be built.

This work will require about 6,000 linear feet of pile-dike, which, at $8 per foot, will cost $48,000, and will therefore largely increase the estimate of 1884. This will probably bring up the amount required for the completion of the present project from $94,000 to $120,000.

Out of the amounts appropriated up to June 30, 1886, more than $35,000 have been expended on repairs.

A careful examination of the dikes between New Baltimore and Albany, made in 1886 by Assistant Engineer R. H. Tallcott, showed them to be in very bad condition, and his estimate for repairs needed on them was as follows:

1. West Dike at New Baltimore, completed last year	$12,165
2. Mull's Dike, half dike (single pile)	5,000
3. Barren Island Dike	1,500
4. Coeymans Dike	300
5. Middle dike at Coeymans, completed last year	12,366
6. Roah Hook Dike, completed last year	2,877
7. Mull's Plaat, half dike	50
8. Mull's Single Pile Dike	23,400
9. Scodach Island Dike	300
10. Shad Island Dike	450
11. Castleton Dike	1,300
12. Cedar Hill Dike	11,000
13. Cow Island Dike	9,500
14. Campbell Island Dike	300
15. Campbell Island Dike (single pile)	500
16. Winnie's Landing, lower dike (single pile). (Staat's Island Pile Dike, an entirely new structure will have to be built.)	600
17. Winnie's Dike	4,500
18. Bear Island (single pile-dike)	6,000
19. Extension of Overslaugh Dike	150
20. Overslaugh Dike, repairs	9,000
21. Beacon Island Dike (single pile)	250
Papscanee Dikes:	
22. Section No. 3	1,000
23. Section No. 2	900
24. Section No. 1	4,500
25. Bogart's Island (single pile-dike)	1,500
26. Douw's Point Extension (single pile-dike)	800
27. Douw's Point Extension (double pile-dike)	250
28. Douw's Point Dike	1,340
29. Small Island Dike	1,350
	85,390
To which should be added 20 per cent. for contingent expenses and deteriorations	17,160
Total estimated cost of repairs required to dikes between New Baltimore and Albany	103,000

Of these repairs those at the west dike, New Baltimore, and at the Roah Hook Dike have been completed during the past year by J. B. Marshall & Co., under their contract, and those at the middle dike at Coeymans by William D. Fuller, under his contract for that work.

Both contracts were dated October 7, 1886.

The cost of the materials as put into the work was as follows:

1. West dike at New Baltimore:	
Piles, 40,507 linear feet, at 13 cents per foot	$5,274.10
Yellow pine timber, 33,454 feet, B. M., at $45 per 1,000 feet	1,505.43
Iron, 1,518 pounds, at 6 cents per pound	919.08
Stone filling, 3,275.9 cubic yards, at 75 cents	2,456.92
Total	10,155,53

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2. Roah Hook Dike:	
Piles, 14,495 linear feet, at 13 cents per foot	$1,884.33
Yellow pine timber, 7,915 feet, B. M., at $45 per 1,000 feet	356.17
Iron, 5,163 pounds, at 6 cents per pound	310.08
Stone filling, 566 cubic yards, at 75 cents	424.50
Total	2,975.10
3. Middle dike at Coeymans:	
Piles, 53,949.5 linear feet, at 12½ cents per foot	6,878.56
Yellow pine timber, 28,878 feet, B. M., at $45 per 1,000 feet	1,212.88
Stone filling, 1,537.75 cubic yards, at 75 cents	1,153.31
Iron, 24,986.4 pounds, at 6 cents per pound	1,499.18
Total	10,202.76

After the contract for the repair of the middle dike at Coeymans had been formed, it was found necessary to rebuild a part of its upper end 70 feet in length. Under authority from the Chief of Engineers, dated September 5, 1887, this work was done by hired labor at a cost of $988.20, the small cost involved not justifying advertising.

The cost of the material built into the work was as follows:

Piles, 3,015 linear feet, at 12½ cents per foot	$384.41
Yellow pine timber, 3,613 feet, B. M., at $42 per 1,000 feet	151.75
Tie-rods, drift and screw bolts, 1,459 pounds, at 6 cents	87.54
Sheet-iron and chains to protect the breaker, 370 pounds, at 9 cents per pound	33.30
Stone filling, 441.6 cubic yards, at 75 cents	331.20
	988.20

The dikes between Albany and Troy are equally in bad condition. Base Island Crib Dike on the east side of the river opposite Cuyler's Island, built in 1870, will have to be rebuilt for 2,000 feet.

The single pile-dike, built in 1879, extending up-stream from the lower end of Lower Patroon's Island is practically carried away, and should be rebuilt and extended up-stream so as to connect with the lower dike of Patroon's Island, built in 1870. This would require 2,600 feet of diking. Two breaks, one 550 feet long and the other 350 feet long, Patroon's Lower Dike should be closed.

There has been so much filling behind those dikes since they were built, that probably a cheaper form of construction than that formerly used could be used there safely now.

The water averages only a foot in depth at mean low water along the line of the dikes.

A dike outside of the old line and consisting of two rows of piles 14 feet long cut off 1 foot above high water, and suitably braced, would probably, at present prices, not cost more than $5 per running foot of dike; and with the backing it would have from the remnants of the old dike and from the ground which has filled in behind it, it would be stronger than the original dikes.

The revetments along the face of Patroon's and Hillhouse islands are wearing away, but not sufficiently so to make their repair necessary for the present.

There are two breaks in the Port Schuyler Dike, one 200 and the other 100 feet in length. These should be repaired without delay as a large amount of water is at ebb tide deflected from the main channel through them, and twice during freshets a large amount of material has been washed down the back channel past Hillhouse and Cuyler's islands into the main channel below. The cost of repairing these two breaks by a pile-dike 8 feet wide would be about $10 per linear foot.

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The total cost of repairing the dikes above Albany would be then as follows:

1. Base Island Dike, 2,000 feet, at $5 per linear foot	$10,000
2. Rebuilding Lower Patroon's Single Pile Dike and connecting it with Lower Patroon's Crib Dike, 2,600 feet, at $5	13,000
3. Repairing breaks in Lower Patroon's Dike, 900 feet, at $5	4,500
4. Repairing breaks in Port Schuyler Dike 300 feet, at $10	3,000
Contingencies, 20 per cent	6,500
Total repairs required from Albany	37,000

This estimate was not included in the last Annual Report.

The whole amount needed therefore for the repair and completion of the works on the Upper Hudson is as follows:

For the repair of dikes below Albany	$103,000
For the repair of dikes above Albany	37,000
For the construction of the permanent works needed to complete the project now under execution (estimate given above)	120,000
Total	260,000

The whole of this amount could be profitably expended in one season, and the work would be more economically done were the whole amount needed appropriated in one sum.

The channels remain in about the same condition as last spring. Nine feet can easily be carried at ordinary low water to Albany, and 7 feet to Troy.

The usual bars have formed this spring at Mull's Cross-over through the action of ice-jams and freshets, although dredged last fall by the State of New York. It was originally intended that the channel should follow the west bank of the river at this point, but, as rock was found at a depth of 9 feet, or less, below mean low water, it became necessary for economical reasons, to throw the current of the river towards the east side by the construction of a pile-dike from Shad Island to Mull's.

The pile-dike is in a very dilapidated condition and should be rebuilt entirely and extended by crib-work down-stream.

The usual shoal has also formed this spring at the Overslaugh and Bogart's Island, and, as stated in my last annual report, is due probably to the condition of the Papscanee dikes, which are in such bad repair that they do not effect their purpose, which was to contract the channel width and throw the current along Bogart's Island and the Overslaugh.

Two shoals have been found this spring between the railroad bridges at Albany.

The State of New York has dredges now at work on Mull's Crossover and the shoals between the bridges and Albany; and it is understood contracts for dredging were to be let about the 29th of June.

This annual dredging does no permanent good. The old dumping places behind the dikes are filled up, and the present system appears to be to dump the dredged material along the channel-face of the nearest dike, and after the dredging of the channel is completed to move the dredge to the dike and lift the dumped material over or upon the dike, as may be most convenient. When the material is left on top of the dike the waves of every steam-boat passing at high water wash it back again into the channels below.

It is more than probable that the filling in of the channel this year opposite Patroon's Island is caused by the material dredged from that bar by the State last year and deposited on the upper end of the dike; and that the shoals formed at the Albany bridges are caused by the wash of the material which has been deposited upon the Bath Dike. Both of

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these dikes last year were covered up with material from 6 to 10 feet high, and now scarcely a trace of it is left.

The same may be said of the shoal at the Overslaugh, as the material was deposited on the Douw's Point Dike, which has entirely disappeared since last fall.

Most of the material dredged last fall from Mull's Crossover was dumped behind Schermerhorn and Shad islands; but this year it is being dumped in front of the State Dike built between Scodach Island and Mull's Plaat, with the intention of finally lifting it over or upon the dike.

It is certain that 50 per cent., if not more, of the material dredged finds its way back into the channels by being washed down from the top of the dikes.

This system of work ought to be changed and some method adopted for transferring the material dredged to the places where it can not possibly get back again into the channel.

A full statement of the commerce of the river was given in my last annual report.

AMOUNTS APPROPRIATED.

By act of Congress approved—	
June 30, 1834	$70,000
July 2, 1836	100,000
March 3, 1837	100,000
July 7, 1838	100,000
August 30, 1852	50,000
	420,000

AMOUNTS APPROPRIATED FOR PRESENT PROJECT.

By act of Congress approved—	
June 28, 1864, allotment	$33,000.00
June 23, 1866	50,000.00
March 3, 1867	305,188.00
July 25, 1868	85,000.00
April 10, 1869	89,100.00
July 11, 1870	40,000.00
March 3, 1871	40,000.00
June 10, 1872	40,000.00
March 3, 1873	40,000.00
June 23, 1874	40,000.00
March 3, 1875	40,000.00
August 14, 1876	50,000.00
June 18, 1878	70,000.00
March 3, 1879	30,000.00
June 14, 1880	20,000.00
March 3, 1881	15,000.00
By act of Congress passed August 2, 1882	10,000.00
By act of Congress approved July 5, 1884	30,000.00
August 5, 1886	26,250.00
Total	1,053,538.00
Received from other sources	792.57
	1,054,330.57
Amount expended to June 30, 1888	1,032,137.59

Money statement.

July 1, 1887, amount available	$23,018.50
July 1, 1888, amount expended during the fiscal year, exclusive of liabilities outstanding July 1, 1887	1,560.22
July 1, 1888, balance available	21,458.28
Amount appropriated by act of August 11, 1888	75,000.00
Amount available for fiscal year ending June 30, 1889	96,458.28

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Amount (estimated) required for completion of existing project	$185,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	185,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS OF THE PORT OF ALBANY, NEW YORK, FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

[From A. D. Cole, esq., surveyor of the port.]

Value of imports	$945,381.00
Duties collected thereon	152,916.10

The following are extracts from the report of the Hon. John Shanahan, superintendent public works, State of New York, for the year 1887, on trade and tonnage of canals:

	Tons.	Value.
Arriving at tide-water of the Hudson River at Albany and Troy	3,158,923	$71,755,221
Merchandise that went to New York	2,252,943	60,075,597

E 2.

IMPROVEMENT OF SAUGERTIES HARBOR, NEW YORK.

The harbor of Saugerties is the name applied to the mouth of Esopus Creek, which empties into the Hudson River, on the west shore, about 100 miles above the city of New York. With the exception of some slight works undertaken by the inhabitants, giving no permanent results, nothing had been done toward the improvement of this harbor until it was undertaken by the United States Government in 1887. In 1883 a survey of the harbor was made under the direction of General John Newton, Corps of Engineers, who suggested two plans of improvement, both providing for the construction of parallel dikes and for dredging the channel between them. See Annual Report of the Chief of Engineers for 1884, Part I, page 716.)

A re-examination of the harbor, made in 1887, after the State had done some dredging in the channel, resulted in the submission of a third project, differing but slightly from those previously submitted, the main difference being in the location. This project was approved and its execution was begun the same year.

Its estimated cost was as follows:

North dike, 2,300 feet long:	
Pile-work, 2,160 running feet, at $7 per foot	$15,120
Crib-work, 140 running feet, at $30 per foot	4,200
South dike, 2,300 feet long:	
Pile-work, 2,200 running feet, at $7 per foot	15,400
Crib-work, 100 running feet, at $30 per foot	3,000
Dredging 30,000 cubic yards, at 25 cents	7,500
Contingencies, about 15 per cent	6,780
Total	52,000

As the $20,000 which had been appropriated for this improvement in 1884 and 1886 was only sufficient to build one of the proposed dikes, it was decided to apply it to the south dike only, leaving the other to be provided for by subsequent appropriations.

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Bids for its construction were therefore invited by public advertisement, and the work being awarded to Messrs. Henry Du Bois's Sons, at $6.79 a linear foot of dike, a contract, dated July 28, 1887, was entered into with them accordingly.

The construction was begun August 18 and was continued until the 1st of December, 1887, when work closed for the season, and as the contract had been delayed by reason of bad weather, the time for its completion was extended to June 15, 1888.

Upon the resumption of the work in the spring of 1883, it was found that the dike had been somewhat injured by the ice during the winter. For 50 feet from the inner end the piles had been broken off, and at about 1,000 feet from the shore end the dike had been lifted slightly for a distance of about 100 feet and pushed over towards the south, but not enough to impair its strength or efficiency.

The broken piles have been replaced by the contractor. The dike is now completed. It is 2,363½ feet in length and consists of a double row of piles driven 6 feet apart from center to center, the tops of piles being cut off 2 feet above mean high water. Two courses of timber 6 by 12 inches are bolted along the inner and outer faces of the dike, and the space between the piles is filled in with stone. The rows of piles are tied together at intervals of 12 feet with timber cross-ties 12 by 12 inches, and with two iron tie rods between the timber cross-ties.

For the completion of the work in accordance with the approved plan, the sum of $32,000 is required.

A full statement of the commerce of Saugerties may be found in my last annual report. No additional information concerning it has been received.

Saugerties is the collection district of Albany, N. Y., which is the nearest port of entry. The nearest light-house is at the mouth of Esopus Creek.

AMOUNTS APPROPRIATED.

July 5, 1884	$5,000.00
August 5, 1886	15,000.00
Total	20,000.00
Amount expended to June 30, 1888	13,363.14

Money statement.

July 1, 1887, amount available		$19,939.95
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$13,303.09	
July 1, 1888, outstanding liabilities	3,938.17	
		17,241.26
July 1, 1888, balance available		2,698.69
Amount appropriated by act of August 11, 1888		12,000.00
Amount available for fiscal year ending June 30, 1889		14,698.69

Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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Abstract of bids for building a pile-dike at Saugerties Harbor, New York, opened at the United States Engineer Office, Army Building, New York, July 20, 1887, at 12 o'clock m., under advertisement of June 27, 1887.

No.	Names of bidders.	2,300 feet of dike.	
		Rate per linear foot.	Amount.
1	Joseph L. Powley, Rondout, N. Y	$7.93	$18,239.00
2	Alexander Sturgeon, Rondout, N. Y	8.85	20,335.00
3	John Satterlee, Inglewood, N. J	8.20	18,860.60
4	Stephen A. Kelly, Brooklyn, N. Y	9.63	22,195.00
5	Ross & Sanford, Jersey City, N. J	10.40	22,920.00
6	Henry Du Bois's Sons, New York, N. Y	6.79	15,617.00
7	Richard Parrott, Newburgh, N. Y	(*)	.....

* The price entered in this bid of Mr. Parrott had been altered by erasure and interlineation in so careless a manner that it was impossible to determine what amount was intended, although the bidder said it was $7.

Abstract of contract entered into during the fiscal year ending June 30, 1888.

Name.	Date.	Purpose.	Price per linear foot.	Amount.
Henry Du Bois's Sons	July 28, 1887	Building 2,300 feet of pile-dike.	$6.79	$15,617.00

E 3.

IMPROVEMENT OF THE HARBOR AT RONDOUT, NEW YORK.

Rondout Harbor is formed by the mouth of Rondout Creek, which empties into the Hudson River on its west side, about 90 miles above the city of New York. The creek is a tidal stream for 3 miles above its mouth. Prior to 1871 improvements had been made by private persons and corporations, but no permanent benefit had been derived from them. In 1869 a survey of the harbor was made by the Government, with a view to its permanent improvement, and it was then found that the available depth of water in the channel was about 7 feet.

The project of improvement based upon this survey provided for the formation and maintenance of a channel 100 feet wide and 14 feet deep at the mouth of the creek, to be obtained by means of dredging and diking. Two parallel channel-dikes were to be built outward toward and into the Hudson River, their outer ends curving gently downstream, while a branch dike running up-stream along the Hudson from the outer end of the north dike was to protect that dike from destruction by running ice. The estimated cost of this work was as follows:

Building the north dike, 748 yards long	$41,600
Building the branch dike, 640 yards long	34,400
Building the south dike, 1,277 yards long	59,600
Dredging a channel 3,000 feet long, 100 feet wide, and 14 feet deep at low water, 48,000 cubic yards, at 30 cents	14,400
Contingencies	22,500
Total	172,500

The final length of the north and south dikes was, however, to be determined after observing the effects which they might produce in the

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removal of the bar as they were gradually extended outward. The work was begun in 1872 and was completed in 1880. It was found by experience that the dikes might be shortened so much below the lengths originally deemed necessary for them; that the total cost of the work was reduced to $90,000, a little more than one-half the original estimate.

On the completion of the work the north dike was about 2,200 feet long; the branch dike, running up the Hudson, was about 1,000 feet long; the south dike was about 2,800 feet long, with a spur to the lighthouse 330 feet long, while a channel wide enough for existing commerce and 13½ feet deep had been obtained along the north dike. A history of the improvement may be found in the Annual Report of the Chief of Engineers for 1881, Part I, page 494.

The appropriations for this harbor made since the completion of the works in 1880 have been applied exclusively to the repair of the dikes, the channel being in a very satisfactory condition, it having a depth of about 14 feet at mean low water. The appropriation of $2,500 made by act of Congress approved August 5, 1886, has been applied during the past year to their further repair, and to protect them with fender-piles.

Bids for this work were called for by circular letter dated August 8, 1887, and a contract was formed accordingly with J. L. Powley under date of August 31, 1887. He did not begin work, however, until October 28, but as his contract was nearly finished at the designated time, it was thought best to extend it to December 31, when it was completed.

The work consisted in driving fender-piles along the channel side of the north dike at intervals varying from 4 feet near the outer end to 50 feet at the inner end; and a cluster of piles was driven to protect the outer end of the south dike against damage by collision.

Two small breaks in the north dike were repaired.

This work cost $2,296.02, and the following materials were made use of:

Oak piles, 42 feet long; aggregate length, 6,977 feet; white-pine timber, 11,427 feet, board measure; iron and chain, 6,080 pounds.

The channel is in excellent condition, and there is no reason to expect any deterioration in it unless the dikes are carried away. They are now in very bad condition from age and decay, and should be replaced as speedily as possible. Ten thousand dollars could be well applied in this way during the next fiscal year.

The commerce of Rondout Creek is very large, amounting in 1887 to a tonnage of 2,109,716 tons, with a value of $14,326,615. It consists principally of coal, lime, and cement and bluestone, and is carried on in vessels of from 6 to 15 feet draught.

Rondout is in the collection district of New York. The nearest works of defense are those of New York Harbor. A statement of the amount of its commerce will be found in my last annual report. No late information concerning it has been received.

Money statement.

July 1, 1887, amount available	$2,560.36
July 1, 1888, amount expended during fiscal, exclusive of liabilities outstanding July 1, 1887	2,409.14
July 1, 1888, balance available	151.22
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,151.22
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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Abstract of bids for repairing the dikes at Rondout Harbor, New York, opened at the United States Engineer Office, Army Building, New York, August 18, 1887, at 12 o'clock m., under circular letter of August 8, 1887.

No.	Name of bidders.	White-oak piles, 7,000 linear feet.	Yellow-pine timber, 15,000 feet B. M.	Iron, 5,000 pounds.	Stone, 40 cubic yards.	Amount.
		Cents.		*Cents.*		
1	J. L. Powley	22	$40	5	$1	$2,430
2	Thomas Sturgeon	20	45	8	1	2,515

Abstract of contract entered into during the fiscal year ending June 30, 1888.

Name.	Date.	Purpose.	Price.	Amount.
J. L. Powley	Aug. 31, 1887	7,000 linear feet piles	22 cents linear foot	$1,540
		15,000 feet, B. M., yellow-pine timber.	$40 per 1,000 feet	600
		5,000 pounds iron	5 cents per pound	250
		40 cubic yards stone	$1 per cubic yard	40
Total				2,430

E 4.

IMPROVEMENT OF THE HARLEM RIVER, NEW YORK.

The streams included in this improvement are the Harlem River and Spuyten Duyvil Creek. The former empties into the East River near Hell Gate, and the latter into the Hudson River, and together separate Manhattan Island from the mainland. The two streams interchange waters at Kingsbridge, but two bridges, with only short spans of from 10 to 15 feet, form dams and prevent a free interchange. The Harlem River is navigable as far as Morris Dock for vessels of from 12 to 15 feet draught, and that is practically the head of navigation at present, though light-draught boats can go as far as Fordham Landing, 1 mile farther. Spuyten Duyvil Creek is navigable at high water as far as Kingsbridge for vessels drawing 8 feet. The range of the tides in Harlem River varies from 5.2 feet at Third Avenue Bridge to 6 feet at the mouth of Dyckman's Creek, near the head of navigation. The tides in Spuyten Duyvil Creek have a range of about 4 feet. A full history of this improvement, and the legal proceedings for the acquirement of the land needed for it, is to be found in the Report of the Chief of Engineers for 1887, Part 1, page 665.

The present project for the improvement was adopted in 1879. The route selected being the one recommended by General Newton in his report in 1875, a change being made in the width of the proposed channel from 350 to 400 feet, except in the rock cut through Dyckman's Meadow. The depth of the channel to be excavated is 15 feet at mean low water except in the rock cut, when 18 feet will be the depth.

The original estimate for the cost of the work was in round numbers $2,700,000.

The field and office work necessary for the establishment of the lines of the improvement between the Hudson and Harlem rivers and the borings for the determination of the material through which the canal prism was to be excavated which were in progress at the end of the last fiscal year were continued, and the latter were finished August 20.

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The total number of borings made was 141, with a total length of 6,278 feet, and ranging in depth from 9 to 112 feet.

As soon as the triangulation was completed a series of cross-sections for the accurate determination of the quantity of material to be removed from the cut through Dyckman's Meadow was begun, and the necessary field work and calculations were completed the latter part of October.

Though it would have been more economical to carry on the work through the marsh south of the foundry and rolling mill at the same time that the excavation of the rock cut through Dyckman's Meadow was in progress, and to make use of the rock excavated in structures for the protection of the sides and bottom of the new channel through the marsh, the amount of the appropriation would not admit of such a division, and it was therefore decided to apply the appropriation to the excavation of the rock cut through Dyckman's Meadow, and to store the rock from the cut on leased land adjoining the work until the opportunity for using it in the work should occur. With this in view a strip of land of about 7⅓ acres was leased from Mr. Isaac M. Dyckman at the rate of $1,000 per year, the lease to begin on December 1, 1887.

Bids for excavating 150,000 cubic yards of material, more or less, from the cut through Dyckman's Meadow were advertised for October 13, and were opened November 9, 1887. Mr. John Satterlee's bid was the lowest, at 93 cents for excavation above mean low water and $1.13 for excavation below mean low water, all expenses of dams and pumping to be borne by the contractor. Owing to doubts of Mr. Satterlee's ability to do the work, the contract was not awarded for some weeks. On December 15, Mr. Satterlee having furnished the required bonds, the work was awarded to him and the contract signed. The price bid for the excavation was so much less than had been anticipated, that the quantity to be excavated under this contract was increased to 300,000 cubic yards, more or less; and, as laid out on the ground, it will include about 60,000 cubic yards of earth and loose rock and about 250,000 cubic yards of solid rock, which at the prices for excavation above and below the plane of mean low water will cost about $315,000.

The contractor began preparations for work as soon as the contract was signed, but did not begin excavation until January 9, 1888, and then only with a few teams, stripping the rock. The rock excavation was begun January 19 with a few hand drills, and two steam drills were started January 24. Until March 19 all the material excavated was hauled away on wagons or drags, but on that date the tracks leading from the rock-cut to a trestle with a steep incline for raising the rock, and making a high dump on the ground leased for storage, were put in operation, and have worked fairly well ever since. The earth stripping, except on the marsh, is still hauled away on wagons and carts and used for filling up lots belonging to private individuals.

The weather, which up to the middle of December had been quite mild and dry, at that time became very cold and stormy, and during the months of January, February, and most of March continued to be very unfavorable for the work. On March 12 an unprecedented storm of wind and snow visited this section of the country, and for a week no work was done. For three days communication with the lower part of the city was entirely cut off by heavy snow-drifts both on the railroads and streets. The location of the work is very much exposed, and the cold northwesterly winds sweeping through the valley of the Spuyten Duyvil and the gap through which the cut is being excavated made it impossible at times for the men to work without risk of freezing their

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hands and feet. During the month of April the weather was more favorable, but the month of May was very wet and much time was lost. The progress of the work was very slow, and on March 31 only 10,921 cubic yards had been removed from the cut, which was about one-fifth of the amount called for by the contract. The last three months the progress has been better, but so far has not reached the contract stipulation of 20,000 cubic yards per month.

A short dam built entirely of earth has been made across Dyckman's Creek, near the Kingsbridge road, to keep out the Harlem River water, and a long dam on the marsh composed of a double row of piles with wooden braces and iron tie rods, and a continuous row of tongued and grooved sheet-piling on the outside, and banked over for a width of about 6 feet on top with the marsh sod, has been completed on the side of the cut toward Spuyten Duyvil Creek.

Since the completion of the dams a large pump has been put in operation and an attempt made to lift the mud overlying the rock on the westerly end of the work under contract, and to deposit it on the adjoining marsh. At first, owing to the roots, which extended to a depth of from 8 to 10 feet, the experiment was not very successful, but by using a larger pump the difficulties have been overcome and the pump is now lifting the material very well. The water needed is supplied and controlled by a flood-gate in the large dam.

The following table shows the progress of the work to June 30 and the amount excavated in each month:

During—	Above mean low water.	Below mean low water.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
January	2,266	.....	2,266
February	4,678	.....	4,678
March	3,977	.....	3,977
April	7,715	.....	7,715
May	10,930	.....	10,930
June	12,450	1,472	13,922
Total	42,016	1,472	43,488

The material through which a part of the canal prism must be excavated is so nearly semi-fluid that it necessitates some sort of protection to the sides, and probably to the bottom of the cut, to prevent abrasion by the currents, which will be quite strong at certain times of the tides after the channel is opened. In order to arrive at some idea of what would be required, and the probable cost of such protection, it was decided to experiment with a crib of round timber, and a mattress of the same, to be framed and sunk alongside of each other in a trench dredged for their reception in the marsh, their load to be put on gradually to permit compacting the sub-strata, if possible.

A point near the mouth of Spuyten Duyvil Creek was selected for this purpose, which was far enough away from the present channel to prevent these operations from being any obstruction to it. On April 13 bids for furnishing timber and drift-bolts for this work were advertised for and May 3 they were opened. Mr. Enoch L. Richardson was the lowest bidder for the timber, at $25 per 1,000 feet B. M. for square timber, and 5⅜ cents per linear foot for the round timber, and Mr. John Timmes was the lowest bidder for the drift-bolts at 2.4 cents per pound. Mr. George E. Richardson was engaged to do the work of framing and

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sinking the crib at 1⅞ cents per cubic foot for the timber work, and 75 cents per cubic yard for the stone delivered in the cribs. A dredge was hired from the Morris & Cumings Dredging Company at $90 per day, and a trench 200 feet long, 13 feet deep at mean low water, and 40 feet wide at the bottom was dredged for the reception of the crib-work and timber mattress. The amount of material dredged from the trench was 6,335 cubic yards, and it was removed at a cost of about 27.9 cents per cubic yard. The crib-work has been framed to a depth of about 17½ feet, and will be settled in its place and sunk as soon as the necessary stone can be obtained. In order to get the stone from that stored from the cut through Dyckman's Meadow, a new front with other repairs was required to an old dock. That work has been begun and will be completed in a few days. As soon as the crib is filled with stone the experiment of a mattress will be undertaken. It is also proposed to try an experiment with loose stone, to test the penetration of the stones into the mud, with a view to using riprap should it be found practicable to do so.

The amount that can be profitably expended upon the work during the next fiscal year is $1,000,000, as it can not be well or economically conducted unless the appropriations are large.

The work has been under the personal supervision of Civil Assistant R. H. Talcott, C. E., by whom the original surveys under General Newton were made in 1874; and it has been conducted with ability and good judgment.

Harlem River is in the collection district of New York. The nearest light-house is on Blackwell's Island.

A full statement of the commerce likely to be benefited by the improvement is given in my last annual report. See Report of Chief of Engineers for 1887, Part I, page 665.

APPROPRIATIONS.

June 23, 1874, allotment from appropriation for East and Harlem rivers	$11,000
By act of Congress approved March 3, 1875	10,000
June 18, 1875	300,000
March 3, 1879	100,000
Total	421,000

Amount expended to June 30, 1888, $62,179.68.

Money statement.

July 1, 1887, amount available		$399,012.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$41,179.68	
July 1, 1888, outstanding liabilities	18,286.07	
July 1, 1888, amount covered by existing contracts	268,261.76	
		327,729.51
July 1, 1888, balance available		71,282.72
Amount appropriated by act of August 11, 1888		70,000.00
Amount available for fiscal year ending June 30, 1889		141,282.72

Amount (estimated) required for completion of existing project	2,230,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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Abstract of bids for improving Harlem River, New York, by excavating 150,000 *cubic yards of material, more or less, from the cut through Dyckman's Meadow, opened at United States Engineer Office, Army Building, New York, November* 9, 1887, *at* 12 *o'clock m., under advertisement of October* 13, 1887.

No.	Name of bidder.	Above mean low water 75,000 cubic yards.		Below mean low water 75,000 cubic yards.		Total.
		Rate per cubic yard.	Amount.	Rate per cubic yard.	Amount.	
1	Bernard Mahon, New York	$2.00	$150,000	$5.00	$375,000	$525,000
2	A. M. Newton, New York	1.34	100,500	1.34	100,500	201,000
3	P. Sanford Ross, Jersey City, N. J	1.35	101,250	1.95	146,250	247,500
4	John Cox & Co., New York	1.19	89,250	1.19	89,250	178,500
5	Edward Moore, Portland, Me	3.00	225,000	4.00	300,000	525,000
6	George G. Turner, Yonkers, N. Y	1.40	105,000	1.55	116,250	221,250
7	John Satterlee, Englewood, N. J	.93	69,750	1.13	84,750	154,500
8	O'Brien & Clark, New York	1.75	131,250	1.75	131,250	262,500
9	Evans & Ackerman, Binghamton, N. Y	1.00	75,000	1.40	105,000	180,000
10	John Sullivan, Catskill, N. Y	1.00	75,000	1.50	112,500	187,500
11	Thos. F. Maney & Co., Boston, Mass	1.50	112,500	2.00	150,000	262,500
12	John A. Bonker, New York	1.90	142,500	1.90	142,500	285,000
13	Ripley, Smith & Brown, New York	1.24	93,000	1.49	111,750	204,750
14	William E. Dean, New York	1.35	101,250	1.45	108,750	210,000

Abstract of bids for improving Harlem River, New York, for construction material for crib revetment in Spuyten Duyvil Creek, opened at the United States Engineer Office, Army building, New York, May 3, 1888, *at* 12 *o'clock m., under advertisement of April* 13, 1888.

No.	Name of bidder.	Timber.			20,000 pounds drift bolts.	Amount.
		Round timber.		Square timber.		
		40,000 linear feet spruce or hemlock.	4,600 linear feet spruce.	8,000 feet B. M. Georgia pine.		
		Price per linear foot.	Price per linear foot.	Price per M feet, B. M.	Price per pound.	
1	George Karr & Co., New York, N. Y.	$0.06	$0.06	$24.00	.....	2,868.00
2	Enoch L. Richardson, New York, N. Y	.05⅝	.05⅝	25.00	.....	2,597.25
3	James D. Leary, New York, N. Y	.05½	.05½	29.00	.....	2,852.25
4	James DuBois, New York, N. Y	.06¼	.06¼	25.00	$0.03	3,587.50
5	Rowland A. Robbins, New York, N. Y	.....	.....	.....	.02 44/100	488.00
6	John Temines, Brooklyn, N. Y	.....	.....	.....	.02 1/10	480.00

James DuBois also bid 7¼ cents per linear foot for round white pine.

Abstract of contracts entered into during the fiscal year ending June 30, 1888, *for improving Harlem River, New York.*

Date.	Name.	Purpose.	Price.	Quantity.	Amount.
Dec. 15, 1887	John Satterlee	Excavation above mean low water.	$0.93	122,475 cu. yds.	113,901.75
		Excavation below mean low water.	1.13	178,191 cu. yds.	201,355.83
May 16, 1888	Enoch L. Richardson	Round timber	.05⅝	44,600 lin. ft	2,397.25
		Square timber	25.00	8,000 ft. B. M	200.00
May 16, 1888	John Temines	Drift bolts	.02 1/10	20,000 lbs	480.00

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E 5.

REMOVING OBSTRUCTIONS IN THE EAST RIVER AND HELL GATE.

A description of this channel and of previous work in it is given in my last annual report, which will be found in the Annual Report of the Chief of Engineers for 1887, Part I, page 689.

The East River is crooked and narrow in places, and much obstructed by rocks and affected by violent currents.

The worst of these obstructions is that known as Hell Gate, lying at the mouth of Harlem River, between Blackwell's and Ward's islands, about opposite Ninety-sixth street, New York.

Here the river turns at right angles around Hallet's Point, divides into several channels and runs with a velocity varying at different stages of the tide from 3 to 10 miles an hour, over or around Hallet's Point, Negro Point, Way's Reef, Shell Drake, Pot Rock, Frying Pan, Heel Tap, Holmes's Rock, Hog's Back, Flood Rock, Hen and Chickens, Gridiron, The Negro Heads, Mill Rocks, Rhinelander's Reef, and Bread and Cheese.

On account of the violence and irregularity of the currents and the crowded condition of this passage, wrecks at Hell Gate have been numerous for many years, though they have greatly decreased in number since the improvement of the channel was begun in 1867 under plans prepared by General Newton. At that time some of these rocks projected above the water level, while the least depths over the others at mean low water varied from nothing to 1½ feet. General Newton's plan was to cut away the rocks and reefs that lay directly in the channel to a depth of 26 feet at mean low water, and to build sea-walls or dikes on some of the others which lay near the edges of the channel in order to guide the currents and prevent them from rushing over the rocks and carrying upon them the vessel which might come within their reach.

Such a wall has been built by the United States between Great and Little Mill Rocks, and the city authorities have built a similar protecting wall on the reef known as Bread and Cheese, at the head of Blackwell's Island.

The project of improvement provided for the removal at Hell Gate to a depth of 26 feet at mean low water of the reef at Hallet's Point, Way's Reef, and Shell Drake, Pot Rock, Frying Pan, Heel Tap, Negro Point, and Flood Rock, including the Gridiron, Hen and Chicken, and Negro Heads, and the construction of sea-walls on the Mill Rocks, Hog's Back, and Holmes's Rock, and in other parts of the East River for the removal of Diamond Reef and North Brother's Island Reef to a depth of 26 feet, Coenties Reef to a depth of 25½ feet, and the small rocks known as Scaly Rock, Blackwell's Rock, Pilgrim Rock, and the rock off Woolsey's Bath-house.

At the close of the last fiscal year the following parts of this project had been executed:

Hallet's Point, covering 3 acres, Way's Reef, Shell Drake, Diamond Reef, North Brother's Island Reef, Coenties Reef, Scaly Rock, and Pilgrim Rock had been removed to the depth contemplated in the project; Heel Tap had been broken to 26 feet, and dredged to 22.5 feet; and the least depths on Frying Pan and Pot Rock were 18 feet, and 22.8 feet at mean low water respectively; Flood Rock and connecting reefs covering 9 acres had been broken to 30 feet, and their removal was in progress, the Negro Heads and Hen and Chickens having been reduced to 18 feet

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mean low water, and a new 18-foot channel 320 feet wide opened across the reef. The total cost of this work was $3,571,613.

These results have been of the greatest value to navigation.

Under their contract of November 16, 1886, the Atlantic Dredging Company continued work upon the removal at Flood Rock, working their largest dredge day and night until December 1, 1887, after which date the work proceeded by daylight only. November 23, 1887, the contract was extended by the Chief of Engineers until April 15, 1888, and it was completed on that date.

The following table shows in detail the work done under the contract:

Number of machine.	Number of days worked.	Number of days worked double.	Number of hours worked.	Number of surface blasts fired.	Pounds of dynamite fired.	Number of tons of broken rock removed.	Number of tons raised per day.	Cost of surface blasting per ton raised.
Work done during the past fiscal year:								
Packard's No. 6	74	130	2,357$\frac{35}{60}$	128	12,150	19,548,324	58.53	$0.13
Total work done under contract dated November 16, 1886:								
Packard's No. 6	200	196	4,396$\frac{7}{60}$	258	26,500	41,712,635	70.46	$0.133
Packard's No. 5	123	.....	901$\frac{25}{60}$	42	3,300	7,805,088	63.45	0.088
Total	323	196	5,297$\frac{32}{60}$	300	29,800	49,517,723	.....	0.126

Cost of dynamite for surface blasting, 21 cents per pound.
The dredge broke her boom December 3, 1887, and lost five days replacing it.
Total removed since the explosion and up to June 30, 1888, 83,685 tons.

The progress of the work has been much delayed by the accumulation of small stone on the reef after it has been worked over a considerable time, which fills up the spaces between the larger blocks, preventing the grapple from taking hold of them, and is too fine itself to remain in the grapple while it is being hoisted through the swift current. No practical method of coping with this difficulty has as yet been found. Some delay and difficulty also occurred, during the absence of the engineers in charge of the work, from inadvertently setting the dredge at work on a part of the rock that had not been mined. In other respects the progress of the work has been highly satisfactory, excellent results being obtained with the dredge so long as the surface of the reef remains moderately clear.

The work done under the last contract has added about 60 feet to the width of the new 18-foot channel.

The machinery and other plant stored at Astoria, as well as the drill-scow and other vessels moored at Mill Rock, have been kept in order during the year. The expense of taking care of this property is considerable; it deteriorates to some extent with age, and much of it will be out of date if kept much longer. On the other hand, if sold at auction it would bring very little in proportion to what it would cost to replace it. The drill-scow has begun to leak considerably, though it was hauled out and put in order in 1884, since the last time it was used.

It is apparent that a considerable saving to the United States would result from making the appropriations for this work large enough to admit of putting all this machinery at work before it ceases to be serviceable, without interrupting the work on Flood Rock, the removal of which is an immediate necessity.

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Hell Gate is the worst of the obstructions which are found in the East River; but there are many other rocks and reefs in other parts of this crowded water-way which are constant sources of danger to passing vessels, which have been often complained of and which ought to be removed. There is a long line of reefs and isolated rocks in mid-stream, extending a mile and a half downward from the foot of Blackwell's Island, which have always been troublesome to vessels beating up against the wind or crossing from one channel to the other, as the winds and tides often compel them to do, and which, with the continually increasing size of vessels and the increasing commerce of the river, are becoming still more dangerous. The worst of these ought to be removed now.

The expenses incurred on account of the improvement during the year amount to $49,460.34, of which $383 remained outstanding at the close of the fiscal year. They are distributed as follows:

Dredging 19,548.32 tons of rock	$38,901.50
Inspection and surveying	1,779.49
Care and preservation of mining plant at Astoria	2,747.85
Care and preservation of drill-scow and floating plant	2,369.26
Administration	3,662.24
Total	49,460.34

The amount that can be profitably expended in the removal of obstructions in East River and Hell Gate during the next fiscal year is $500,000, to be applied to the removal of Flood Rock chiefly, and also to continuing operations with the steam drill-scow on the other obstructions in the East River and at Hell Gate, before mentioned.

It is especially desirable that the appropriation for this work should be liberal, not only in order that the extensive plant on hand may be kept at work, but because there is but one dredging company in the United States that has dredges that can do the work on Flood Rock efficiently; and as there is, therefore, no competition, reasonable bids for contract work can only be secured by the appropriations being sufficiently large to make it possible to reject unreasonable bids and purchase the necessary machinery to do the work by day labor.

Nothing further has been heard of the suit begun last year to dispossess the United States of its occupancy of the dike built by it between Great and Little Mill rocks.

The work is in the collection district of New York. The nearest port of entry is New York City. The nearest light-house is Blackwell's Island Light.

A full statement of the commerce making use of Hell Gate was published with my last annual report, which will be found in the Annual Report of the Chief of Engineers for 1887, Part I, page 689.

AMOUNTS APPROPRIATED.

By acts of Congress approved—	
July 25, 1868	$85,000.00
April 10, 1869	178,300.00
July 11, 1870	250,000.00
March 3, 1871	250,000.00
June 10, 1872	225,000.00
March 3, 1873	225,000.00
June 23, 1874	225,000.00
March 3, 1875	250,000.00
August 14, 1876	250,000.00
June 18, 1878	350,000.00
March 3, 1879	250,000.00
June 14, 1880	200,000.00
March 3, 1881	200,000.00
May 4, 1882	50,000.00

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By act of Congress passed August 2, 1882		$200,000.00
By act of Congress approved—		
July 5, 1884		360,000.00
August 5, 1886		112,500.00
Received from other sources		3,719.62
		3,664,519.62
Deduct amount reverted to U. S. Treasury	$3,158.55	
Deduct amount allotted to Harlem River	11,000.00	
		14,158.55
		3,650,361.07
Amount expended to June 30, 1888		3,633,892.91

Money statement.

July 1, 1887, amount available		$24,717.62
Received from sales of fuel to officers		52.49
		24,770.11
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,301.95	
July 1, 1888, outstanding liabilities	383.00	
		8,684.95
July 1, 1888, balance available		16,085.16
Amount appropriated by act of August 11, 1888		250,000.00
Amount available for fiscal year ending June 30, 1889		266,085.16
Amount (estimated) required for completion of existing project		1,238,840.67
Amount that can be profitably expended in fiscal year ending June 30, 1890		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Commercial statistics of the port of New York for the fiscal year ending June 30, 1888.

Amount of revenue collected	$145,300,544.35
Value of all imports	470,426,724.00
Value of all exports	334,929,956.00

	Number.	Registered tonnage.
Foreign vessels entered	3,815	4,754,927
Foreign vessels cleared	3,803	4,783,448
American vessels from foreign ports	1,514	882,105
American vessels cleared for foreign ports	1,021	744,848
Coastwise vessels entered	2,182	.....
Coastwise vessels cleared	3,093	.....

E 6.

IMPROVEMENT OF NEWTOWN CREEK, NEW YORK.

Newtown Creek is a sluggish stream, about 4 miles long, running through the eastern part of Brooklyn and emptying into the East River opposite Thirty-fourth street, New York.

In 1857 it had a depth of about 17 feet, which had decreased in 1880 to about 12½ feet at low water from its mouth up to the Vernon Avenue Bridge, a distance of 1,100 feet, its width for this distance being about 240 feet; thence it gradually decreased in width and depth until at the head of navigation, where the Metropolitan Avenue crosses it, there was a low-water depth of about 4 feet and a width of about 100 feet.

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A survey of this creek with a view to its improvement was ordered by act of Congress approved March 3, 1879, and was made under General Newton's directions, and was reported upon by him January 31, 1880. The project which he presented provided for dredging a channel from the mouth of the creek to Vernon Avenue Bridge, 200 feet wide and from 18 to 21 feet deep at low water, requiring the removal of 145,000 cubic yards of material, chiefly mud, the cost of which was estimated at $36,250.

Work under this project was begun in 1880, but by reason of increased cost of dredging the estimated cost was increased to $44,050.

Under the act of Congress passed August 2, 1882, another survey was made under the direction of Major Gillespie, whose report is dated December 26, 1883. His project provided for carrying the improvement from the Vernon Avenue Bridge up to the head of navigation in both branches of the creek. The estimated cost of executing this project was as follows:

To excavate a channel 18 feet deep and 175 feet wide, from Vernon Avenue Bridge to the Central Oil Works, 143,500 cubic yards excavation, at 30 cents per cubic yard	$43,050
Thence 15 feet deep and from 125 to 150 feet wide, to Queens County Oil Works, 101,600 cubic yards excavation, at 35 cents per cubic yard	35,560
Thence 12 feet deep and 125 to 150 feet wide to Nichol's Chemical Works, 52,600 cubic yards excavation, at 40 cents per cubic yard	21,040
Thence 10 feet deep and from 100 to 125 feet wide, to the head of navigation on both branches, 231,600 cubic yards excavation, at 40 cents per cubic yard	92,640
Contingencies	19,229
To which must be added the revised estimate for work below Vernon Avenue Bridge, before given	44,050
Total estimated cost of improving Newtown Creek	255,569

Up to June 30, 1886, $45,000 of this amount had been appropriated, and with it the channel below Vernon Avenue Bridge had been given a depth of 18 feet, with a width varying from 75 feet at the bridge to 150 feet at the mouth of the creek; and channels 10 feet deep and from 50 to 200 feet in width had been dredged from Covert's Dock up to the bridge at Metropolitan avenue and Grand street, on the west branch, and to Grand Street Bridge on the east branch, the distance being about 3,000 and 1,000 feet, respectively.

The act of Congress approved August 5, 1886, appropriated $37,500 for the improvement, but directed that $9,375 should be expended on the west branch, between Maspeth avenue (Covert's Dock) and what is called the Dual Bridge, at Grand street and Metropolitan avenue, $9,375 on the main branch between Easterly Grand Street Bridge and Metropolitan avenue, and the balance on the lower end from Maspeth avenue to the mouth.

Proposals were accordingly invited March 2, 1887, by public advertisement, for dredging 70,000 cubic yards of material from the lower part of the creek between its mouth and the Vernon Avenue Bridge, and 35,000 cubic yards from the west branch above Easterly Grand Street Bridge, and 25,000 cubic yards from the west branch at the upper end of the creek.

The depths to be obtained were to be respectively 21 feet at mean low water in the lower part of the creek and 10 feet in the upper part.

The bids were opened April 6, 1887, but as they were all too high they were rejected, and other bids were asked for by circular letter dated April 22.

By this circular letter the depth to be secured in the lower part of the

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creek was fixed at 18 feet at mean low water instead of 21 feet, as previously advertised.

These bids were opened April 29, 1887.

Morris & Cumings were the lowest bidders, and a contract was entered into with them May 10, 1887, to dredge 70,000 cubic yards of material from below Maspeth avenue, at 32 cents per cubic yard, and 50,000 cubic yards of material from above Maspeth avenue, at 34½ cents per cubic yard.

Work under this contract was begun May 24, on the lower part of the creek between the mouth and the Vernon Avenue Bridge.

Just below Vernon Avenue Bridge it was found a number of telegraph and telephone wires and oil-pipes crossed the stream at depths varying from 15 to 17 feet below mean low water. The owners were communicated with, and were requested to remove them temporarily in order that the dredging might go on, and this was readily agreed to.

The work continued till September 12, 1887, during which time 70,000 cubic yards of material were excavated, giving a channel 18 feet deep and 200 feet wide from the 18-foot curve in the East River up the creek for 1,100 feet; thence for the next 800 feet up the creek 18 feet deep and 175 feet wide; thence up to Vernon Avenue Bridge, a distance of 500 feet, 18 feet deep and 140 to 150 feet wide. The material removed consisted of mud, clay, and a few large bowlders, but principally of material which had evidently been dredged and dumped in the channel by private parties. This was especially noticeable at the mouth of the creek, where it has been the custom to bring dump-scows down the creek with a small tug and mooring them to a buoy, so that they might be taken out to sea at night by a large tug and dumped.

It is a significant fact that the worst shoaling was found just around this mooring buoy, showing either that the scows leaked badly or that the material was willfully dumped there to save 40 miles towing. There is no doubt at all that the latter is the true cause of the formation of this shoal.

On the 28th of June, 1887, work under the same contract was begun on the upper easterly branch of the creek, above Maspeth avenue, and was continued up to September 12; when on this branch, between the Easterly Grand Street Bridge and the Metropolitan Avenue Bridge, a channel from 100 to 125 feet wide and from 8½ to 10 feet deep at mean low water had been dredged.

The amount of material removed here was 25,175 cubic yards.

On the western branch of the creek, between Maspeth avenue and the Dual Bridge work was begun August 6 and was completed September 10, 1887, during which time 25,071 cubic yards of material were excavated.

Besides this a cut from 35 to 50 feet wide and 10 feet deep was excavated from Maspeth avenue to the Dual Bridge on the western side of the channel, a small cut 50 feet wide was made around the bend, and a cut varing from 25 to 35 feet wide was made on the east side of the channel from the second bend up to Dual Bridge.

The rise and fall of the tide in the creek is about 4.5 feet, but the bed of the creek has no natural slope.

The creek itself is a receptacle for all the refuse from the sewers, factories, and slaughter-houses of the east of Brooklyn. Constant deposits are therefore forming in it, especially at the upper end, from these causes and from the caving in of the unprotected banks, which consist of marsh mud. To remedy this difficulty, annual dredging will be

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needed until the banks are protected by bulkheads throughout their whole length.

The commerce of the creek is so large that this improvement should be pushed at least 3 miles up from the mouth as soon as possible. Many of the ships going above Vernon Avenue Bridge ought to load to a draught of from 20 to 23 feet; but at present they can only take on a part of their load in the creek, through which they can carry perhaps only 16 or 17 feet, and must then finish loading at the wharves in deeper water in the East River.

It is recommended that $100,000 be appropriated for continuing this improvement, which should be carried up-stream continuously.

The wording of the appropriation of August, 1886, prevented the application of any part of it to that part of the creek lying between the forks and the Easterly Grand Street Bridge, up to which point, under the unexpended balance of the appropriation of July, 1854, it was only possible to make a channel 50 feet wide.

It would have been better for the work had the appropriation been made in such a way that the improvement above the bridge could have been made as an extension of the improvement below it, since these improvements are now separated by a narrow cut to which, under the wording of the law, no part of the last appropriation could be applied.

This work is in the collection district of New York. Nearest port of entry, New York City; nearest light-house, Blackwell's Island Light; nearest fort, Fort Columbus.

Amounts appropriated.

Date.	Application.	Amount.
June 14, 1880	Dredging below Vernon Avenue Bridge	$10,000
Aug. 2, 1882	Dredging below Vernon Avenue Bridge	15,000
July 5, 1884	Part applied above Vernon Avenue Bridge	20,000
Aug. 5, 1886	Below and above Vernon Avenue Bridge	37,500
	Total	82,000

Amount expended to June 30, 1888 ..... $80,957.17

A full statement of the commerce of Newtown Creek will be found in the last annual report.

Money statement.

July 1, 1887, amount available	$2,577.23
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,034.40
July 1, 1888, balance available	1,542.83
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	26,542.83
Amount (estimated) required for completion of existing project	148,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 to 1867.

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E 7.

IMPROVEMENT OF BUTTERMILK CHANNEL, NEW YORK.

Buttermilk Channel is the name given to the channel which separates Governor's Island, at the mouth of the East River, New York Harbor, from the city of Brooklyn, which lies east of it.

The channel on the northwest side of Governor's Island, which separates it from the lower end of the city of New York, is the wider and the deeper of the two, and is the channel most used by vessels passing between the East River and the other parts of New York Harbor.

Buttermilk Channel is obstructed by three shoals:

1. A shoal lying above and northeast of Governor's Island, projecting into Buttermilk Channel, and extending over to the main channel on the other side, which originally had a least depth over it of 9½ feet at mean low water.

2. A shoal, putting out from Red Hook Point, on the Brooklyn side, and extending up to the eastern side of the channel to the entrance of the Atlantic Basin, with a least depth on it of about 5 feet at mean low water.

3. A shoal putting out from the southern side of Governor's Island and extending towards the Red Hook Point Shoal, which is partly dry at mean low water.

A narrow and crooked channel about 30 feet deep lies between the two latter shoals.

Between the first-mentioned shoal and Governor's Island is a narrow channel with 20 feet of water in it, and between this shoal and the Brooklyn shore there is a channel of the same depth, also originally narrow, but widened now to about 900 feet.

The line of docks and wharves from the Brooklyn Bridge down to the mouth of the Atlantic Basin, on the Brooklyn side, is one of the most important in New York Harbor; and this part of the river, extending from the Brooklyn Bridge to Governor's Island, is regarded by pilots and masters of vessels as one of the most difficult places in New York waters to carry a vessel through safely, on account of this shoal, the rapid current, and the enormous traffic passing, not only up and down, but across the stream.

Tows, tugs, small steamers, and small craft generally, in passing up and down this part of the East River, keep to the New York side, forcing the larger class of sound steamers, ocean steamers, and sea-going ships in tow of tugs, to keep over towards the shoal at the upper point of Governor's Island, and if, as is often the case, these vessels are obliged to stop in order to avoid collision with ferry-boats, sloops, and canal-boat tows, they are liable to drift upon this shoal.

Upon a statement of these difficulties, made by shipping merchants and others whose business lay along the Brooklyn wharves between Wall Street Ferry and the Atlantic Basin, a survey of this shoal was ordered in 1872, and a project for its improvement was adopted in 1880.

This provided for the removal, to a depth of 26 feet at mean low water, of such parts of this shoal as lay within 850 feet of the line of the Brooklyn wharves.

The estimated cost of this improvement was $140,000, which provided for the removal of 570,000 cubic yards of material, at the rate of 23 cents per cubic yard, with 12 per cent. added for contingencies.

The first appropriation for this work was made June 14, 1880, since which time other appropriations have been made, under which the work

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was carried on up to November 3, 1884; but, owing to the distance from the place of excavation to the place where the dredged material had to be dumped, which is outside of Sandy Hook, a distance of about 20 miles, the prices bid for the work were more than 50 per cent. greater than had been anticipated, and the estimated cost of the improvement had to be increased, therefore, to $210,000, of which $190,000 had been appropriated up to June 30, 1886.

Under these appropriations 466,276 cubic yards of material were removed from the shoal, deepening the water over the part removed certainly to 24 feet and probably to 26 feet at mean low water, with some shallower spots. It was too late in the season when the work closed, however, to determined this by a survey. The part removed included the original crest of the shoal, leaving no part of it on which there should have been a less depth than 17 feet.

But it is probable that this least depth was not attained, since a survey, made in June, 1884, showed that a material shoaling had taken place on undredged parts of the shoal since the first work had been done, amounting at that time to about 37,000 cubic yards, which, if distributed, would have reduced the depths on the undredged parts of the shoal to 13 feet at mean low water, instead of 17, as it should have been had no such deposit been made.

This shoaling is probably due to the fact that the city authorities have a scow anchored on the shoal, to which tugs, steam-lighters, and small steamers transfer their ashes, and during this transfer a part of the ashes probably falls overboard between the steam-boat and the scow.

The recommendation was made in my annual report for 1885 that the width of this channel should be increased from 850 to 1,150 feet, unless it should be decided to remove the whole shoal to a depth of 26 feet at mean low water; and $50,000 was recommended for beginning the further widening of the channel.

When the last detailed survey of the shoal was made in June, 1884, it appeared that the excavation of about 336,057 cubic yards of material would be required for the removal of the whole shoal; of this amount 30,097 cubic yards were taken out under the contract, which was terminated in November, 1884.

This left 305,960 cubic yards yet to be taken out in order to complete the removal, which, at 50 cents per cubic yard, would cost about $150,000.

In view, however, of the shoaling which is known to have occurred during the progress of the work, it seemed advisable to increase this estimate by $20,000, making a total of $170,000 required for the removal of the whole shoal.

The large and increasing traffic of this part of the river certainly warrants the removal of the whole shoal.

This recommendation that the whole shoal should be removed was tacitly accepted by Congress in the appropriation of $56,250 for the work, made by act of Congress approved August 5, 1886, since this appropriation was larger than the amount recommended for widening the channel only.

In the application of this appropriation it would be more advantageous to commerce to remove the whole shoal down to a depth of 22 feet at mean low water rather than to remove a part of it only to the proposed eventual depth of 26 feet, leaving other parts with 16 or 18 feet of water above them. Bids for the work were therefore invited by public advertisement, dated October 29, 1886, and a contract was formed accordingly with the United States Dredging Company, who were to do the dredging at 23½ cents per cubic yard. As they failed to

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comply, however, with any of the terms of their contract, it was annulled, and an agreement was made with Henry DuBois' Sons to do the work at 25 cents per cubic yard. (See the last annual report on Buttermilk Channel for details.)

Work under DuBois' contract was begun in March and finished in October, 1887, during which time 186,638 cubic yards of material were removed, and a depth of 22 feet at mean low water had been secured over the entire shoal.

To remove the remainder of the shoal down to the desired depth of 26 feet below mean low water will require, according to the survey of 1884, and taking into consideration the filling which is going on there, the removal of 165,000 cubic yards of material, which, at 50 cents per cubic yard, will cost $82,500; add for contingencies, $12,500; total, $95,000.

A reef or shoal in this part of the river lying only about 350 feet from Diamond Reef, which was removed in 1879–'80, is an obstruction to navigation, since there is a depth of about 20 feet over it at mean low water. This may be removed, as Diamond Reef was under the appropriation for East River and Hell Gate, should that title of appropriation be restored.

The commerce of this part of New York Harbor is very large, consisting of all the East Indian, West Indian, South American, and most of the Continental European trade. This is carried principally in steamers drawing from 19 to 23 feet of water.

The number of sea-going vessels using the wharves adjacent to Buttermilk Channel for the fiscal year ending June 30, 1887, was 4,150, with a tonnage of 3,058,504 tons, and the value of the merchandise which they carried was $154,829,062. This, however, does not take into consideration the coastwise and passing trade; it appears, therefore, of importance that this improvement should be carried out.

This work is in the collection district of New York. The nearest port of entry is New York City, and the nearest work of defense Fort Columbus, New York Harbor. The amount of revenues from customs collected is the amount collected at the port of New York.

Amounts appropriated.

Date.	Application.	Amount.
June 14, 1880	Dredging	$60,000
Mar. 3, 1881	....do	60,000
Aug. 2, 1882	....do	60,000
July 5, 1884	....do	10,000
Aug. 5, 1886	....do	56,250
	Total	246,250
	Received from other sources	100
		246,350

Amount expended to June 30, 1888, $240,492.84.

A full statement of the commerce of Buttermilk Channel accompanied the last annual report upon it.

Money statement.

July 1, 1887, amount available	$9,461.94
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	3,604.78
July 1, 1888, balance available	5,857.16
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	105,857.16

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E 8.

IMPROVEMENT OF GOWANUS BAY, NEW YORK.

Gowanus Bay is a part of New York Harbor, lying at the mouth of Gowanus Creek, in the southwestern part of the city of Brooklyn. The depth of water in the channel was formerly from 7 to 12 feet at mean low water, which was wholly insufficient for the passage of the vesse s employed in the commerce of the district. A survey of Gowanus Bay and Creek was made in 1880, and a project for their improvement was submitted in January, 1881.

This project provided for dredging a channel between the pier lines established by the commissioners appointed by the State of New York in 1875, beginning at the bay and extending up the creek to Hamilton Avenue Bridge, 18 feet deep at mean low water and 200 feet wide, except for the upper few hundred feet near the bridge, where the width was to be gradually reduced from 200 feet to 100 feet. The total length of the proposed channel was about 9,000 feet.

The estimated cost of this improvement was as follows:

530,000 cubic yards of dredging, at 30 cents per cubic yard	$159,000
Contingencies	23,850
Total	182,850

The proposed channel, however, did not follow the old channel at the mouth of the creek, since the pier line established by the commission crossed the old channel at that point, and the land under water inside of it, including the bed of the old channel, had become private property.

The owners of this property, Messrs. Beard and Robinson, were anxious, nevertheless, to have the old channel improved, instead of having the new one formed, as proposed, outside of the established pier line; but, as this could not be done unless they surrendered their right to build out to the pier line, they signed a paper relinquishing their right to build piers which should obstruct the old channel so long as that channel should be permitted to exist; and the Maritime Association of New York at the same time petitioned that the old channel should be kept open. As the improvement of this channel would, however, help only the land near it on the north side, and not at all that which lay on the opposite or southerly side of the creek, General Newton recommended that the conflict of interests be settled by dredging the natural channel from the Hamilton Avenue Bridge down to the southwest corner of the Erie Basin; and that from that point two channels should be dredged, one running northerly along the west side of the Erie Basin to deep water near Red Hook, and the other running southerly along the wharves on the south side of the bay, toward Bay Ridge.

Both of these channels were to be 200 feet wide and 18 feet deep at mean low water. This project required for its execution a larger amount of work than the original scheme called for, namely:

The excavation of 583,530 cubic yards of material, which, at 30 cents per cubic yard, would cost	$175,059.00
Contingencies, 10 per cent	17,505.90
Total	192,564.90

The legal measures necessary for securing the right of way across Beard and Robinson's property, at the mouth of the creek, were not

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completed satisfactorily until May, 1883, but under appropriations of 1881, 1882, and 1884 the proposed Red Hook branch of the channel was dredged 100 feet wide for a length of 2,000 feet, measured from Red Hook, and the southern channel, running towards Bay Ridge, was begun at the southern end, and carried northward for a distance of 1,900 feet, with depths in it varying from 21 to 17 feet, except for a few hundred feet at the upper end on the eastern side where the last cut was left unfinished.

The act of Congress approved August 5, 1886, appropriated $7,500 for the continuance of this work. This amount was too small either to benefit the improvement much, or to secure low rates for the work. It was advertised, however, and bids were opened on the 23d of October, 1886, for extending the channel up the creek for about 1,500 feet above the end of the old dredged channel, or to within 600 feet of the Hamilton Avenue Bridge. The depth to be obtained was 18 feet, and the width was to depend upon the price bid.

All the bids received were high, but it was nevertheless recommended that the lowest bid be accepted, "as no economy would probably result from re-advertising."

The recommendation was approved, and a contract was entered into December 22, 1886, with Elijah Brainard, the lowest bidder, who was to do the dredging at 32 cents per cubic yard.

Work under this contract was begun February 4, 1887, and was continued until March 12, 1887, when it was stopped. During this time 21,497 cubic yards of material were removed from the channel.

Two parallel cuts, each about 20 feet wide at the bottom and 18 feet deep, were made along the northern channel line of the creek from a point opposite the foot of Twenty-third street to one opposite the foot of Sixteenth street, Brooklyn, a distance of about 1,500 feet.

The material varied very much in character, from hard compact yellow clay to soft black mud; the mud overlies the clay, as a rule, to the depth of 2 feet.

Although a depth of 18 feet was obtained by the dredge, the soft material filled into the cut again so rapidly that, at the close of the dredging, sounding showed a depth of only 15 feet, and that the cut was about 40 feet wide at bottom, with a top width varying from 55 to 75 feet; but it is not likely that even this depth will be maintained in so narrow a cut.

At the close of the work, March 12, 1887, the condition of the channel in Gowanus Bay and Creek was as follows:

What may be called the Red Hook Channel, running round the Erie Basin to the mouth of the creek, had been practically completed for its full width and depth, and the channel leading from it up the creek had been completed to within 2,100 feet of Hamilton Avenue Bridge, with a further extension 15 feet deep and 40 feet wide at bottom for 1,500 further up the creek.

What may be termed the Bay Ridge Channel, south of the mouth of the creek, had been begun at its outer or southern end, and had been carried up with nearly full depth and width to a point 2,000 feet south of the mouth of the creek.

The following work yet remains to be done under the original project:

The completion of the channel up the creek, 2,100 feet to the Hamilton Avenue Bridge, and the extension of the southern or Bay Ridge Channel northward so as to connect with the Red Hook Channel at the mouth of the creek.

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A sketch of the condition of this improvement June 30, 1885, may be found in the Annual Report of the Chief of Engineers for 1885, Part I, page 672.

Under the present estimate of $192,564.90, only $72,500 have been appropriated to June 30, 1887.

The project should be completed as soon as possible.

Large manufacturing and shipping interests are growing up along the banks of the creek, for which the present depth of 18 feet at the mouth and 8 feet at the upper end of the creek are wholly inadequate.

In 1871, when the first project for its improvement was adopted, 18 feet was the depth of water which the commercial men interested in the improvement asked for; now owners of the water-fronts are petitioning for 21 feet, and yet only half of the original project has been completed.

Apart from the creek, the Red Hook and Bay Ridge channels in the bay, as stated in my annual report for 1886 (page 723), are very important to passing commerce, and would be used when completed by vessels of a large class.

A letter from one of the leading merchants of New York and Brooklyn, published on page 713 of my annual report for 1887, inclosing a petition signed by many firms interested in the improvement of both Gowanus Bay and Buttermilk Channel, gives a fair idea of the growing necessities of the commerce of the port of New York which seems to indicate the need of the early completion of this improvement.

From this letter it appears that there is not now enough wharf-room in the harbor, vessels frequently having to pay a bonus of $75 or $100 a day for the privilege of using wharves for which there is a constant demand, and that the improvement of Buttermilk Channel and the Gowanus Bay channels, which constitute a very large part of the water front of Brooklyn, and which are included in the East River district, of which 63.7 per cent. of the commerce of the port of New York make use, would give very great relief, especially if the low-water channel depth were increased to 21 feet instead of 18 feet, as was proposed last year, since it would permit the construction of many more wharves.

To complete the Gowanus Bay channels, as originally proposed, making them 200 feet wide and 18 feet deep at low water, would require, under previous estimates, the expenditure of $120,000. The work could be much better and more cheaply executed were this whole amount made available in one appropriation.

But there can be no doubt that these dimensions are too small in view of the great increase in length and draught which has taken place recently in the construction of sea-going vessels, especially steamers. The depth of these channels ought to be increased now to 21 feet at low water and their width to 400 feet, while to facilitate the handling of vessels in the contracted space near the mouth of Gowanus Creek, more room should be gained by cutting away the angle on the south side.

To make these changes in the channels would involve the removal of 1,345,000 cubic yards of material in place as follows:

Red Hook Channel—		
To deepen it to 21 feet	cubic yards..	70,000
To widen it to 400 feet	do....	100,000
		170,000
Bay Ridge Channel—		
To deepen it to 21 feet	cubic yards..	250,000
To widen it to 400 feet	do....	275,000
		525,000

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Gowanus Ceeek Channel—		
To deepen it to 21 feet	cubic yards..	350,000
To cut away the angle	do....	300,000
		650,000
Total in place		1,345,000
Which, at 40 cents per cubic yard, would cost		$538,000
Contingencies		62,000
Total		$600,000

Gowanus Bay is in the collection district of New York City. Nearest light, Robbin's Reef.

Nearest work of defense, the fort on Governor's Island, 1 mile to the northward.

ORIGINAL ESTIMATE.

Dredging 583,530 cubic yards, at 30 cents	$175,059.00
Contingencies, 10 per cent	17,505.90
Total	192,564.90

Amounts appropriated.

Date.	Application.	Amount.
Mar. 30, 1881	Dredging	$40,000
Aug. 2, 1882	....do	20,000
July 5, 1884	....do	5,000
Aug. 5, 1886	....do	7,500
	Total	72,500

Amount expended to June 30, 1888	$72,436.69
Estimate for channels 400 feet wide and 21 feet deep at low water	600,000.00

COMMERCIAL STATISTICS.

The following statement concerning the commerce of Gowanus Bay, New York Harbor, was given in my last annual report:

Receipts and shipments.

Articles.	Quantity.	Values.
Coal ....tons..	170,000	$595,000
Brick	160,000,000	1,120,000
Lumber ....feet, B. M..	75,000,000	1,500,000
Lime, etc ....barrels..	370,000	555,000
Grain ....bushels..	11,000,000	7,700,000
Ice ....tons..	100,000	300,000
Roofing tar ....barrels..	100,000	200,000
Building stone, etc		350,000
Total		12,320,000

Vessels arriving and departing.

Articles.	Quantity.	Tonnage.
Steamers	25	17,840
Ships	65	82,179
Barks	311	605,371
Brigs	72	25,381
Schooners	296	64,256
Total	769	793,027

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Many steam-tugs, canal-boats, and lighters pass in and out of the bay every day, varying in draught from 6 to 12 feet, but no record is kept of these vessels unless they pass through the draw-bridge at Hamilton avenue. The record of those so passing is as follows:

Year.	Number of times opened and closed.	Number of vessels passed through.	Tonnage.	Daily average of times opened.
1881	5,740	4,126	573,949	15
1886	7,632	6,071	985,431	21

Money statement.

July 1, 1887, amount available	$64.31
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1.00
July 1, 1888, balance available	63.31
Amount appropriated by act of August 11, 1888	60,000.00
Amount available for fiscal year ending June 30, 1889	60,063.31
Amount (estimated) required for completion of existing project	60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

E 9.

IMPROVEMENT OF NEW YORK HARBOR.

A description of this harbor and a history of the work already done in the improvement of its Sandy Hook entrance was given in my last annual report, and will be found in the Report of the Chief of Engineers for 1887, part 1, page 717.

The main or Sandy Hook entrance to New York Harbor is one of the best in the world, the channel being about 24 feet deep at mean low water and nearly 29 feet at mean high water, with abundant breadth, and no need for deepening it was ever felt until within the last few years, when the great increase in the length, tonnage, and draught of the transatlantic passenger steamers made further deepening necessary in order to prevent the delays to which they have been subjected by having to wait for high water in order to pass either in or out.

Before the improvement of the main entrance into New York Harbor was undertaken by the United States it was obstructed by four shoals, as follows:

1. The outer bar, about 4,000 feet wide, the channel across which is known as Gedney's Channel, where there wered epths of 23.7 feet in mid-channel and 22.3 feet in the southern half.

2. The shoal at the mouth of the Swash Channel, about 4,000 feet wide, where the depth was 24.3 feet.

The channel across this shoal has been named the Bayside Channel for the following sufficient reason given me in a letter from Captain Derby:

Early in the spring when the first surveys had been made and the work done in the main ship-channel during the winter had been found to be sufficient to admit to

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the upper harbor vessels that could cross the bar, it was decided to have the new channels buoyed so that vessels could use them.

In publishing the notice to mariners describing the new buoys, Commander Mackenzie, U. S. Navy, thought it necessary to give a name to the channel across the shoal west of Gedney's Channel at mouth of the Swash Channel, because considerable confusion had already arisen and some rather unpleasant newspaper correspondence been caused by uncertainty as to the proper name of this spot.

In the published notice he named the channel after the Bayside range which marks its center line—the range of the Bayside Beacon and Waackaack Beacon. The new buoys are numbered B 1, B 2, etc.; and in Gedney's Channel they are numbered G 1, G 2, etc.

3. The shoal northwest of Sandy Hook, about 2,000 feet wide, on which the least depth was 26.2 feet.

4. The shoal in the main ship-channel in the lower bay, nearly 3 miles long, on the crest of which the depth was only 23.9 in mid-channel, with depths of 22.6 within a few hundred feet of the mid-channel range.

A large proportion of the vast commerce of the port which is carried on in vessels of great draught could only cross these shoals at or near high water.

The project for the improvement of Gedney's Channel was approved by the Secretary of War in December, 1884, and its extension to cover the whole of the main entrance to the harbor received his approval December 27, 1886.

It provides for dredging a channel 1,000 feet wide and 30 feet deep at mean low water, from deep water below the Narrows through the main ship-channel and Gedney's Channel to deep water outside the bar; maintaining this channel, should it be necessary, either by periodical dredging, or by contracting the entrance by the construction of a dike running across the shoals from the Coney Island side with suitable protection for the head of Sandy Hook to prevent its being scoured away by the increased current.

The estimated cost of obtaining the dredged channel is $1,490,000, and the entire cost of the improvement should the contraction works prove to be necessary, is estimated at between $5,000,000 and $6,000,000.

Under this project an extended survey of the lower bay had been made on which the method of improvement was based, and 303,869 cubic yards of sand had been dredged from Gedney's Channel at the close of the last fiscal year.

This had resulted in producing a channel of good, navigable width across the bar 25 feet deep at mean low water, but no practical benefit to navigation had resulted since no increase in depth had been obtained on the shoals inside the bar, the application of the funds having been restricted by the language of the appropriation act to Gedney's Channel only.

At the beginning of the fiscal year the Joseph Edwards Dredging Company had not yet begun work under their contracts of April 21 and May 19, 1887, for dredging 2,200,000 cubic yard at 28½ cents per cubic yard from the four shoals in the channel, and owing to the delay of the builders in delivering the dredges, the first of these machines, the *Advance*, originally called the *Bolivar*, did not begin work until August 1, 1887, one month behind time, the *Mount Waldo* did not begin until October 14, two months and a half behind time, and the *Reliance* only started November 26, nearly three months behind time. The season of 1887 was therefore nearly entirely lost, only 180,830 cubic yards having been dredged to January 1, at which time 700,000 cubic yards were to have been removed from Gedney's Channel alone.

All three dredges worked upon Gedney's Channel until December 3,

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when they were transferred to the shoal in the main ship-channel west of Flynn's Knoll.

The largest vessels frequenting the port of New York draw, as ordinarily loaded, about 27 feet in leaving port, but in arriving here they rarely draw over 24½ feet, having lightened themselves by consuming from 1,500 to 2,000 tons of coal during the passage. While it is of course desirable that vessels should be able to leave port at all hours, it is much more important that they should be able to enter without regard to the stage of the tide, for the time of departure can be regulated to suit the tide, but the time of arrival can not. The working of the dredges during the year has therefore been so directed as to secure as early as practicable a channel across all the shoals 500 feet wide and sufficiently deep to admit the largest steamers at low water, leaving for later operations the deepening of this 500-foot channel to 30 feet at mean low water, and its widening to 1,000 feet the full dimensions required by the project. All three of the dredges were accordingly kept on a section of the main ship-channel about 3,000 feet long including the crest of the shoal west of Flynn's Knoll, from December 3 to May 10; the *Reliance* and *Advance* were then transferred to the Bayside Channel until June 11, when the *Reliance* was ordered to Gedney's Channel.

The entire quantity dredged during the fiscal year is 580,405 cubic yards, which, with the 303,869 cubic yards dredged from Gedney's Channel during 1885 and 1886, has produced a channel not less than 500 feet wide, in which the least depths between the steamer wharves and the ocean is 26 feet on the bar and 25.4 feet on the shoal west of Flynn's Knoll in the lower bay.

These dimensions are sufficient to enable the largest steamers arriving off the bar as now loaded to reach their wharves without delay at average low tide, and they also permit any of the large steamers leaving the port at high water, as is usual, to go to sea loaded fully 2 feet deeper than was ever practicable before.

The dredged channels have been thoroughly buoyed, and as soon as the pilots have become familiar with the new channels the port of New York will reap the full benefit of the results.

To test the permanency of the work accomplished a survey of Gedney's Channel by Captain Derby's method was made last December on completion of operations for the season; all soundings were taken with a rod graduated to feet and tenths, and were located by angles read with the transit from triangulation stations established on the shoals near by. This survey was repeated May 30, before dredging on the bar was resumed. A careful comparison of the two surveys shows that no shoaling whatever had taken place in the dredged channel during the six months of boisterous weather that had elapsed since operations were suspended. As a like comparison was made a year ago with precisely the same result, it may be said that the prospect that the dredged channel across the bar will maintain its new dimensions by the action of the currents alone, is most encouraging.

It having been reported in the newspapers that new shoals had formed in the Bayside Channel during the winter, a new survey was made of it in April for comparison with the one made last season. No evidence of shoaling was found; but on the contrary, the agreement between the two surveys was so marked as to give grounds for hoping that this locality may prove as favorable for the maintenance of a dredged channel as the outer bay, which was hardly to be expected as the ebb current of the Swash Channel flows across the Bayside Channel nearly at right angles.

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The work done during the winter on the shoal in the main ship-channel was surveyed April 16, and 177,937 cubic yards measured in place were found to have been removed from the shoal. The quantity removed by the dredges amounted, however, to only 128,453 cubic yards measured in scows, which would not correspond ordinarily to more than 102,762 cubic yards measured in place. It is apparent therefore that the work of the dredges has been materially supplemented by the currents, in fact to the extent of about 73 per cent. It is not known whether the currents are actually attacking the bottom of the channel, or whether this increase in the place measurement is due entirely to the fact that the material is composed of sand mixed with mud, and that the greater part of the latter does not lodge in the bins of the dredges, but is carried overboard by the overflow from the bins and drifted off by the currents in the channel before it has time to settle to the bottom again. The surface currents of the bay at this point run transverse to the channel instead of along its axis, and the tendency is therefore to carry overflow material upon the adjacent shoals. A survey made in June to ascertain whether this material found a lodgment in the channel at some point farther down-stream indicates, on the contrary, that the channel has slightly deepened from natural causes alone, both in the prolongation of the dredged area, where no work has been done, and in the dredged area itself, where work had been suspended for six weeks. These changes, however, though very noticeable, are believed to be too slight, considering the difficulties in the way of exact measurement, to warrant drawing the conclusion that the currents are actually attacking the bottom; but they are highly satisfactory as far as they go, both as regards the prospects of permanency in the dredged channel and as regards the great saving that will result in the cost of carrying out the project, if through the assistance of the currents, the place measurement continues to exceed the scow measurement.

The following table shows the performance of the dredges through out the year:

Name of dredge.	Length of dredge.	Capacity, in cubic yards.	Number of pumps.	Size of suction.	Size of pump engines.	Gedney's Channel.			Bayside Channel.			Main ship-channel.			Total dredged.
						Number of days worked.	Number of cubic yards dredged.	Cubic yards dredged per minute of pumping time.	Number of days worked.	Number of cubic yards dredged.	Cubic yards dredged per minute of pumping time.	Number of days worked.	Number of cubic yards dredged.	Cubic yards dredged per minute of pumping time.	
	Ft.			*In.*	*Inches.*										
Advance	132	140	2	15	12 x 18	85	116,408	5.995	36	61,600	6.012	94	60,351	2.209	238,359
Reliance	156	817	2	20	15 x 20	20	46,240	7.497	22	61,699	10.489	79	75,642	3.461	183,581
Mount Waldo	145	278	2	15	12 x 18	39	36,320	6.175	...	.....	.....	76½	39,669	2.326	75,989
Mount Waldo, with scows	....	....	...	...	.....	....	.....	.....	...	.....	.....	49½	82,476	2.749	82,476
Total	....	....	...	...	.....	144	198,968	.....	58	123,299	.....	299	258,138	.....	580,405

The pumps are of the Edwards pattern (Andrews patent). The dredge *Mount Waldo* is fitted to pump into bins on board or into scows alongside.

The quantity dredged from Gedney's Channel during 1885 and 1886 is 303,869 cubic yards.

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The great difference in the performance of these dredges in the main ship-channel as compared with their work on the outside shoals is due in part to the greater distance from the shoal to the dumping-ground, but mainly to the great difference in the character of the material, which is chiefly a coarse, clean sand in the Bayside and Gedney's channels, and a very fine sand mixed with mud in the main ship-channel.

This latter material is much the more difficult to dredge not only on account of the large percentage of mud too fine to be caught in the bins, but also on account of its lying very compactly on the bottom and being consequently much more difficult to raise with the pump.

The plant put on the work by the contractors does all that was expected of it in Gedney's and Bayside channels, and the dredges *Reliance* and *Advance* will readily complete the work in the time specified in the contract for the Gedney's Channel division. But owing to the difficult character of the material in the main ship-channel, and also to the delays in getting started last season, it is apparent that the contractors can not possibly unaided remove the 1,500,000 cubic yards specified in the main ship-channel contract by December 1, 1888, at which date the contract expires.

It would appear, in fact, that 500,000 cubic yards would be a liberal estimate of the amount that they are likely to accomplish by that date. This fact became apparent as early as November, 1887, and efforts were then made to secure additional plant to assist with the work; but dredge owners objected to putting their plant to work in such an exposed locality so late in the season. These efforts were, however, resumed in the spring, while Colonel Gillespie was in temporary charge of the work, with more success, resulting in agreements being made with Messrs. Brainard Brothers, and with Joseph Cumings, providing for placing on the main ship-channel at the earliest practicable date two more dredges having an estimated daily working capacity of 1,500 and 6,000 cubic yards, respectively. The work is to be done under the specifications of the contract with the Joseph Edwards Dredging Company and to be paid for at the contract price, 28½ cents per cubic yard, scow measurement.

These agreements were approved by the Secretary of War May 16 and May 15, respectively.

Messrs. Brainard Brothers began work June 18, using the dredge *Leo*, formerly employed on the Gedney's Channel work, and described in the Annual Report of the Chief of Engineers for 1886, page 732. They had removed at the close of the fiscal year 3,950 cubic yards of material, but had not got their plant in thorough running order.

Joseph Cumings expects to begin work about July 15. He has chartered the steamship *State of Alabama*, a vessel of 6,500 tons displacement, belonging to the State Line Steamship Company, running between New York and Glasgow, and is fitting her with a large vacuum pump with two 32-inch suctions.

If these new dredges succeed in accomplishing the amount of work that their owners expect of them, the plant now provided for the work will readily complete the removal of the 2,200,000 cubic yards specified in the contracts with the Joseph Edwards Dredging Company by December 1, 1888.

The illegal dumping of refuse and dredged material spoken of in my last annual report has continued throughout the year, greatly to the detriment of the harbor, and at considerable loss to the Government, which in several instances has been obliged to dredge up and remove the material dumped in the channels.

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It is hoped, however, that this vicious practice will be entirely done away with under the provisions of Senate bill No. 1241, which received the approval of the President June 29. This bill, a copy of which is annexed, contains the best provisions of the bill recommended by the Board of Commissioners of Pilots, referred to in my last annual report, since it provides for the fine or imprisonment, or both, of any one aiding or abetting such illegal dumping, half the fine to go to the informer, the taking away of the license of the master or engineer who may engage in it, the libelling of any vessel employed in such work, and lastly fining the owners of the property from which such material is taken as well as the owner of the dredge who does the work, at the rate of $5 for each and every cubic yard of material illegally dumped.

This act applies only to New York Harbor and the waters connected with it. It would be in the interests of navigation and of economy if its provisions were extended to all the navigable waters of the United States which are subject to improvement.

The expenses incurred on account of the improvement during the year amount to $198,182.32, of which $60,467.95 remained outstanding at the close of the fiscal year. They are distributed as follows:

Dredging	$165,413.73
Inspection	3,470.39
Surveying	20,164.16
Administration	9,134.04
Total	198,182.32

The amount needed outside of the present appropriation to widen these channels to 1,000 feet and to deepen them to 30 feet at mean low water, as required by the plan of improvement, is $540,000; and this amount could be well expended in the next fiscal year.

A full statement of commercial statistics relating to the port of New York was given in my last annual report, and will be found on page 928 of the Annual Report of the Chief of Engineers for 1887.

At this port two-thirds of the merchandise imported into the United States is received and two-thirds of the import duties are collected. From this port are sent out one-half of the domestic products of the country which are exported, and here one-half of the foreign tonnage trading with the United States enters. Three-quarters of the passengers traveling between the United States and foreign countries come and go by way of New York, and three-fifths of all immigrants land at Castle Garden.

From January 1 to June 29, 1888, during my absence, this improvement was in temporary charge of Lieut. Col. G. L. Gillespie, Corps of Engineers, U. S. Army.

The work has been under the immediate personal supervision of Capt. George McC. Derby, Corps of Engineers, and the successful results which have been attained are in a very large measure due to his intelligence and his untiring energy and zeal.

AMOUNTS APPROPRIATED.

For Gedney's Channel:	
By act of Congress approved July 5, 1884	$200,000.00
For New York Harbor:	
By act of Congress approved August 5, 1886	750,000.00
Total	950,000.00
Amount expended to June 30, 1887, Gedney's Channel	200,000.00
Amount expended to June 30, 1888, New York Harbor	145,421.10
Total	345,421.10

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Money statement.

July 1, 1887, amount available		$742,293.27
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$137,714.37	
July 1, 1888, outstanding liabilities	60,467.95	
July 1, 1888, amount covered by existing contracts	461,586.27	
		659,768.59
July 1, 1888, balance available		82,524.68
Amount appropriated by act of August 11, 1888		380,000.00
Amount available for fiscal year ending June 30, 1889		462,524.68
Amount (estimated) required for completion of existing project unless it should become necessary to resort to contraction works, which would cost between $4,000,000 and $5,000,000		160,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		160,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Commercial statistics of the port of New York for the fiscal year ending June 30, 1888.

Amount of revenue collected	$145,300,344.35
Value of all imports	470,426,724.00
Value of all exports	334,929,956.00

	Number.	Registered tonnage.
Foreign vessels entered	3,815	4,754,927
Foreign vessels cleared	3,803	4,783,448
American vessels from foreign ports	1,514	882,105
American vessels cleared for foreign ports	1,021	744,848
Coastwise vessels entered	2,182	.....
Coastwise vessels cleared	3,093	.....

PUBLIC—No. 155.

AN ACT to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the placing, discharging, or depositing, by any process or in any manner, of refuse, dirt, ashes, cinders, mud, sand, dredgings, sludge, acid, or any other matter of any kind, other than that flowing from streets, sewers, and passing therefrom in a liquid state, in the tidal waters of the harbor of New York, or its adjacent or tributary waters, or in those of Long Island Sound, within the limits which shall be prescribed by the supervisor of the harbor, is hereby strictly forbidden, and every such act is made a misdemeanor, and every person engaged in or who shall aid, abet, authorize, or instigate a violation of this section, shall, upon conviction, be punishable by fine or imprisonment, or both, such fine to be not less than two hundred and fifty dollars nor more than two thousand five hundred dollars, and the imprisonment to be not less than thirty days nor more than one year, either or both united, as the judge before whom conviction is obtained shall decide, one-half of said fine to be paid to the person or persons giving information which shall lead to conviction of this misdemeanor.

SEC. 2. That any and every master, and engineer, or person or persons acting in such capacity, respectively, on board of any boat or vessel, who shall knowingly engage in towing any scow, boat, or vessel loaded with any such prohibited matter to any point or place of deposit, or discharge in the waters of the harbor of New York, or in its adjacent, or tributary waters, or in those of Long Island Sound, or to any point or place elsewhere than within the limits defined and permitted by the supervisor of the harbor hereinafter mentioned, shall be deemed guilty of a violation of this act, and shall, upon conviction, be punishable as hereinbefore provided for offenses in violation of section 1 of this act, and shall also have his license revoked or suspended for a term to be fixed by the judge before whom tried and convicted.

SEC. 3. That in all cases of receiving on board of any scows or boats such forbidden matter or substance as herein described, it shall be the duty or the owner or master, or

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person acting in such capacity, on board of such scows or boats, before proceeding to take or tow the same to the place of deposit, to apply for and obtain from the supervisor of the harbor appointed hereunder a permit defining the precise limits within which the discharge of such scows or boats may be made; and any deviation from such dumping or discharging place specified in such permit shall be a misdemeanor within the meaning of this act; and the master and engineer, or person or persons acting in such capacity, on board of any tow-boat, towing such scows or boats, shall be equally guilty of such offense with the master or person acting in the capacity of master of the scow, and be liable to equal punishment.

SEC. 4. That all mud, dirt, sand, dredgings, and material of every kind and description whatever taken, dredged, or excavated from any slip, basin, or shoal in the harbor of New York, or the waters adjacent or tributary thereto, and placed on any boat, scow, or vessel for the purpose of being taken or towed upon the waters of the harbor of New York to a place of deposit, shall be deposited and discharged at such place or within such limits as shall be defined and specified by the supervisor of the harbor, as in the third section of this act prescribed, and not otherwise. Every person, firm, or corporation being the owner of any slip, basin, or shoal, from which such mud, dirt, sand, dredgings, and material shall be taken, dredged, or excavated, and every person, firm, or corporation in any manner engaged in the work of dredging or excavating any such slip, basin, or shoal, or of removing such mud, dirt, sand, or dredgings therefrom, shall severally be responsible for the deposit and discharge of all such mud, dirt, sand, or dredgings at such place or within such limits so defined and prescribed by said supervisor of the harbor; and for every violation of the provisions of this section the person offending shall be guilty of an offense against this act, and shall be punished by a fine equal to the sum of five dollars for every cubic yard of mud, dirt, sand, dredgings, or material not deposited or discharged as required by this section. Any boat or vessel used or employed in violating any provision of this act, shall be liable to the pecuniary penalties imposed thereby, and may be proceeded against, summarily by way of libel in any district court of the United States, having jurisdiction thereof.

SEC. 5. That a line officer of the Navy shall be designated by the President of the United States as supervisor of the harbor, to act under the direction of the Secretary of War in enforcing the provisions of this act, and in detecting offenders against the same. This officer shall receive the sea-pay of his grade, and shall have personal charge and supervision under the Secretary of War, and shall direct the patrol boats and other means to detect and bring to punishment offenders against the provisions of this act.

SEC. 6. That the sum of thirty thousand dollars, or so much thereof as may be necessary, is hereby appropriated to carry out the provisions of this act; and the Secretary of the Treasury is hereby authorized to pay that sum from moneys in the Treasury not otherwise appropriated.

Approved, June 29, 1888.

E 10.

IMPROVEMENT OF SHEEPSHEAD BAY, NEW YORK.

Sheepshead Bay, Long Island, is a small tidal bay about 2 miles long, lying inside of Coney Island, New York, and extending easterly from the village of Gravesend to Rockaway Inlet, into which it empties. Its width varies from 100 to 1,000 feet, and its depth from 2 to 10 feet at mean low water.

Its natural mouth, where it connects with Rockaway Inlet, is subject to material frequent changes, from the making and cutting away of the beach and from the changes in the location of the shoals outside caused by storms.

The first survey, with a view to its improvement, of which we have any record, was made in 1879 by General Newton, whose report, dated February 7, 1879, may be found in the Annual Report of the Chief of Engineers for 1879, page 400.

The plan of improvement proposed provided for diking the channel and connecting it with Rockaway Inlet, the estimated cost being $100,000 (incorrectly printed in the Annual Report of the Chief of En-

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gineers as $10,000). Subsequently, as a route less likely to be obstructed by changes in the shoals, it was proposed to connect Sheepshead Bay with Dead Horse Inlet, which flows into Rockaway Inlet some distance higher up.

The first appropriation ($3,000) for this improvement was made June 14, 1880, but General Newton objected to its expenditure for the following reasons:

> The position and even existence of this outlet will depend upon the advance of Rockaway Inlet, which is now advancing westerly at the rate of 264 feet per year.
>
> The total estimate for this improvement is about $100,000, and for this reason and the one cited above I would respectfully recommend awaiting developments and further appropriations. (See Annual Report of the Chief of Engineers for 1880, page 515.)

A second appropriation, of $5,000, was made by act of Congress approved March 3, 1881. For the reasons given before, this appropriation also was not applied to the work.

In 1882 a survey of the mouth of Rockaway Inlet was made which developed great changes in the shoals westward of it, and, based upon this, General Newton suggested making the outlet from Sheepshead Bay into Dead Horse Inlet, instead of directly into Rockaway Inlet as at first proposed.

Two plans with estimates of the cost of doing this were furnished, the first providing for diking as well as dredging; the second omitting the diking. They were as follows:

(1) Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, 6 feet deep at mean low water, 52,000 cubic yards, at 35 cents per cubic yard	$18,200
1,200 feet of creosoted diking to sustain bend in cut, at $6 per linear foot	7,200
7,500 feet of creosoted diking for interior channel, at $5 per linear foot	37,500
Total of first estimate	62,900
(2) Cut to connect Sheepshead Bay with Dead Horse Inlet, 100 feet wide, 6 feet deep at mean low water, 52,000 cubic yards, at 35 cents per cubic yard	$18,200
Dredging interior channel, 40,000 cubic yards, at 40 cents per cubic yard	16,000
Total of second estimate	34,200

The second plan, which omits the diking, is the one that was adopted for the work.

By act of Congress approved August 2, 1882, an additional sum of $3,000 was appropriated for this work, making the total amount available $11,000, less about $650 paid for the surveys. The work was accordingly advertised and let to H. N. and A. J. Beardsley, at 45 cents a cubic yard, for which they were to dredge a cut from Sheepshead Bay into Dead Horse Inlet 40 feet wide and 5 feet deep at mean low water. This contract was begun in November and completed in December, 1883, the dredged material being placed behind a bulkhead built on the north side of the cut by private individuals.

Under the appropriation of $5,000 made by the act of July 5, 1884, the cut was further dredged to a width of 100 feet and a depth of 6 feet at mean low water. This work was done under contract with the Atlantic Dredging Company, at 13½ cents per cubic yard, between August, 1885, and January, 1886.

Under the act of Congress approved August 5, 1886, the sum of $5,000 was appropriated for the further improvement of this bay. But, as there appeared to be no way in which this money could be usefully applied to the work, it was not expended, the place having no commerce and the channel being good enough for the sail-boats that use it.

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Upon the petition of some of the inhabitants of Gravesend, however, it was ordered early in 1888 that this appropriation should be applied to the improvement, and accordingly bids were invited by public advertisement for dredging a channel 60 feet wide and 5½ feet deep at mean low water from the cut in Dead Horse Inlet up to Gravesend.

The lowest bid received, asking 50 cents a cubic yard, was rejected as being too high, and further bids were invited by circular letter. A bid of 39 cents would have been accepted, but in the mean time a second petition had been sent to the Secretary of War asking that the dredging might be deferred until September, as there was some fear that its execution during the summer months might endanger the health of the neighborhood, and it has been deferred accordingly.

Further details of the improvement of Sheepshead Bay may be found in my last annual report.

The actual water commerce through the bay only amounts to $50,000 as given in a statement which was carefully prepared by this office last year.

Sheepshead Bay is not a harbor in any sense of the word, and never will be. The bay is only used for pleasure boats of small draught, belonging to Gravesend and the larger hotels on Coney Island.

The business of the place is done by rail from Brooklyn or by boats which land at the piers on the outer beach, or in Gravesend Bay, and do not come through Sheepshead Bay at all.

There appears, therefore, to be no necessity for making further appropriations for it at present.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light. Nearest fort, Fort Hamilton.

ESTIMATE.

Original estimate of 1879	$100,000.
Revised estimate of 1882	34,200.

Amounts appropriated.

Date.	Application.	Amount.
June 14, 1880	Dredging	$3,000
March 3, 1881	do	5,000
August 2, 1882	do	8,000
July 5, 1884	do	5,000
August 5, 1886	do	5,000
Total		21,000

Amount expended to June 30, 1888, $15,882.44.

Money statement.

July 1, 1887, amount available	$5,283.73
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	166.17
July 1, 1888, balance available	5,117.56
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	10,117.56
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	8,200.00

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Abstract of bids for dredging in Sheepshead Bay, New York, opened at the U. S. Engineers Office, Army Building, New York, March 29, 1888, at 12 o'clock m., under advertisement of February 29, 1888.

No.	Name of bidder.	Residence.	18,000 cubic yards.	
			Rate per cubic yard.	Amount.
1	Michael H. Flannery	New York City	50 cents	$9,000

Proposals incomplete, certificate to justification of guarantors not being furnished. This bid was rejected as being too high.

E 11.

IMPROVEMENT OF THE HARBOR AT CANARSIE BAY, NEW YORK.

Canarsie Bay is the name given to a shoal tidal bay forming the northwestern part of Jamaica Bay, on the south side of Long Island, whose waters flow into the Atlantic Ocean through Rockaway Inlet.

The first survey of this bay with a view to its improvement of which we have any knowledge was made under the direction of General Newton, Corps of Engineers, in 1879.

The scheme of improvement proposed was to obtain a channel 6 feet deep at mean low water extending from the shore at Canarsie Landing to the navigable channel in Jamaica Bay, a distance of about 3,500 feet. This channel was to be obtained by the construction of two pile-dikes, forming a tidal basin, and by dredging them, if necessary, as it was not believed that an unprotected dredged channel would remain permanently open. The estimated cost of this project was $88,000.

The rise and fall of the tide here is 4.7 feet, and the low-water depth is 5 feet.

Between 1880 and 1885 various appropriations have been made for this improvement, amounting altogether to $23,000. With this money the channel has been kept open by dredging, its depth varying from 5 to 6 feet at mean low water and its width from 50 to 125 feet, and the outer part of the north dike, 1,150 feet long, has been built.

A detailed history of the work will be found in the Annual Report of the Chief of Engineers for 1887, part 1, page 637.

By act of Congress, approved August 5, 1886, the sum of $10,000 was appropriated for this improvement. As any attempt to dredge the channel during the summer of 1887 would interfere with the movements of the steamers plying to Canarsie, dredging was deferred for the season.

In January bids were invited by public advertisement for constructing 1,000 feet of the south dike, and a contract was formed accordingly February 25, 1888, with Stephen A. Kelly, for the construction of 850 feet of this dike at $9.87 per linear foot, it being necessary to reduce the total length somewhat in order to leave money enough on hand to do the necessary dredging in the spring.

An examination of the channel made in May, 1888, showed that there were two bars needing dredging, one at the inner end of the north dike and the other near the steam-boat wharf. Under an agreement approved by the Chief of Engineers, a cut 60 feet wide and 6½ feet deep was made through the first-named obstruction, and a cut of the same

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depth and from 60 to 90 feet wide was made through the second one. The channel was also widened about 30 feet at the bend between these obstructions. The total amount removed was 2,946 cubic yards, costing 35 cents per cubic yard, and the work was completed June 18.

Work on the construction of the dike was begun early in May. At the close of the fiscal year the piling had been carried a distance of 590 feet, and 30 feet of the dike had been timbered and prepared to receive the stone filling.

Canarsie, apart from being the terminus of the Brooklyn, Rockaway and Jamaica Bay Railroad, from which people transship by steamer to Rockaway Beach, has a large fishing industry.

Jamaica Bay is most favorable for oyster culture, and most of the oysters are sent to New York by boat or by wagon from Canarsie.

Two steamers make six trips a day from Canarsie to Rockaway during the summer, each drawing about 4 feet of water; and the *Edith Peck* makes four or five trips a day the year round to Barren Island, her draught being 4.8 feet.

As a northwesterly wind often reduces the level of the bay from 1 to 1.5 feet below mean low water, it is apparent that a depth of 6 feet at least, at mean low water, should be maintained in the improved channel.

Judging from the price bid for this year's work, the dike will cost $10 per linear foot instead of $7, as estimated last year, so that the remaining 2,550 feet will cost $22,500.

While the construction of even 850 feet of the south dike will benefit the channel by creating an increased scour, the improved channel can not be considered secure until the whole dike is completed.

Twenty-seven thousand dollars is therefore asked for the completion of the south dike and for such dredging as may become necessary next year.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fort Tompkins Light. Nearest fort, Fort Hamilton.

Amounts appropriated.

Date.	Application.	Amount.
June 14, 1880	Diking	$10,000
Mar. 3, 1881	Dredging	5,000
Aug. 2, 1882	....do	3,000
July 5, 1884	Dredging and diking	5,000
Aug. 5, 1886	....do	10,000
	Total	33,000

Amount expended to June 30, 1888, $24,663.63.

A statement of the commerce of Canarsie Bay will be found in the last annual report upon it.

Money statement.

July 1, 1887, amount available		$10,066.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$1,630.38	
July 1, 1888, amount covered by existing contracts	8,389.50	
		10,019.88
July 1, 1888, balance available		46.87
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		10,046.87

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Amount (estimated) required for completion of existing project	$45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	27,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids for improving Canarsie Bay, New York, by building a pile-dike, opened February 15, 1888.

No.	Name and address of bidders.	1,000 feet of dike.	
		Rate per linear foot.	Amount.
1	O'Connell & Coffee, Brooklyn, N. Y.	$19.75	$19,750
2	Stephen A. Kelly, Brooklyn, N. Y.	9.87	9,870
3	John D. Walsh, Brooklyn, N. Y.	11.17	11,170
4	P. Sanford Ross, Jersey City, N. J.	12.35	12,350
5	Moses Engle, Brooklyn, N. Y.	14.50	14,500
6	George E. Richardson, Brooklyn, N. Y.	13.45	13,450
7	Fearon & Jenks, New York City	11.85	11,850
8	Charles H. Edwards, Quincy, Mass.	12.96	12,960
9	Henry DuBois's Sons, New York City	13.90	13,900
10	Thomas Murray, New Brunswick, N. J.	12.38	12,380
11	Theodore F. Holmes, New York City	13.05	13,050
12	Francis H. Smith, New York City	15.89	15,890

Abstract of contracts entered into during the fiscal year ending June 30, 1888.

Name.	Date.	Purpose.	Price per linear foot.	Amount.
Stephen A. Kelly	Feb. 25, 1888	Building 850 feet of pile-dike	$9.87	$8,389.50

E 12.

IMPROVEMENT OF SUMPAWANUS INLET, NEW YORK.

Sumpawanus Inlet, known in the neighborhood and on the Coast Survey charts as Sumpwams Creek, is a small creek on the south side of Long Island, emptying into Great South Bay, near Babylon.

It lies about 36 miles east of New York City, 15 miles east of the western end of the Great South Bay, and nearly twice as far from its eastern end.

Fire Island Inlet, through which most of the waters of Great South Bay pass into the Atlantic Ocean, lies south-southeast of Sumpwams Creek, distant about 6 miles in a direct line, but 11 miles by the channel.

The inlet is a tidal stream from 100 to 200 feet wide, running up to the town of Babylon, Long Island, which lies less than a mile north of its mouth. It is crossed there by a dam, which forms a reservoir for the fresh water of a small creek, which supplies the town with water.

The mean rise and fall of tides at the mouth of the inlet is only 1.3 feet, and the bottom of the bay and of the inlet is soft mud.

The first survey of Sumpwams Creek of which we have any record was ordered by act of Congress approved June 14, 1880, and was made during the fall of 1888 under the direction of General (then Colonel) John Newton, Corps of Engineers.

His report may be found in the Annual Report of the Chief of Engineers for 1881, Part 1, page 653.

The project of improvement based upon this survey provided for

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dredging a channel 150 feet wide and 5 feet deep at mean low water from the 5-foot curve in the bay to the steam-boat dock at the mouth of the creek, a distance of about 1,500 feet, and thence 5 feet deep and 100 feet wide up the inlet to the town of Babylon, a distance of about 3,500 feet further. The estimated cost of making this improvement was $23,115.

The mean range of tides at the mouth of the inlet being only 1.3 feet, there was practically no current swift enough to produce a scour. The depth of water in the proposed channel at the time of the survey was from 1 to 3 feet in the creek, and from 3 to 5 feet outside.

It was not believed that diking would assist in improving this entrance, and inquiry showed that the depth of water both outside and inside the inlet had materially diminished in late years.

Under acts of Congress approved March 3, 1881, and August 2, 1882, the sum of $7,000 was appropriated for the improvement of this inlet, and was expended under a contract made with John McDermott for dredging at 69 cents per cubic yard, which was 39 cents per cubic yard more than the estimated cost. The dredging was begun in April and was finished in May, 1883, giving a channel 75 feet wide and 5 feet deep from the steam-boat wharf to a point 750 feet below it, besides two cuts, each 25 feet wide, alongside the wharf. In attempting to secure these depths the contractor was compelled to dig to a depth of 5½ or 6 feet below mean low water.

Outside of the cuts so made and extending to the 5-foot curve in the bay a shoal was left, on which the depth was only about 4¾ feet.

An examination made in 1886 showed that since the last dredging was done, in 1883, both the cut and the flat outside had shoaled from 6 inches to a foot, the depth in the cut being about 5 feet, while on the flat it was from 4 to 4½ feet. This was to have been anticipated, as appears by the preliminary report made by General Newton. The 5-foot curve in the bay was 1,500 feet from the steam-boat wharf, but inside this curve, for about 750 feet towards the wharf, lay the flat.

The commerce of Sumpwams Creek is essentially that of Babylon, a small town of from 3,000 to 5,000 inhabitants, 1 mile above the mouth of the creek, depending almost entirely upon the summer trade of the hotels and cottages along the north shore of Great South Bay and on Fire Island Beach.

The commerce of Babylon by water has been decreasing, apparently because the Long Island Railroad has taken away the sea-going business. Babylon itself has improved, and has become a fashionable summer resort. At present its commerce by sea is carried on by three passenger steam-boats, drawing from 4 to 5 feet, running in summer to Fire Island Beach; three schooners, drawing from 5 to 5½ feet, carrying brick, lime, lumber, and other heavy freight to Babylon the year round; 100 sloops and pleasure-boats, drawing from 1 to 2 feet of water, taking out sailing and fishing parties during the summer, of which seven or eight remain in use during the winter, fishing and taking oysters and clams to Patchogue, Sayville, and New York.

No oysters are brought to Babylon from the bay, and only a few clams in the summer for home consumption.

The commerce of the creek, in my judgment, does not warrant the formation of a channel more than 5 feet deep from the 5-foot curve in the bay to the steam-boat wharf, for the convenience of the few steamers and schooners which make use of the creek.

It is stated that the shoals in the bay kill the sea so entirely that pleasure-boats can now lie in the mouth of the creek in all weathers.

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So far as the extension of the improvement from the steam-boat dock up to the inlet is concerned, there appears to be no reason why the Government of the United States should undertake it.

The original estimate of the cost of the work was $23,115. Seven thousand dollars have been appropriated.

Ten thousand dollars can be expended in giving a 5-foot channel out into the bay for the use of steam-boats, but I think that the work is more a matter of local than public interest.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Fire Island Light; nearest fort, Fort Hamilton.

For statement of commerce, see my last annual report.

AMOUNT APPROPRIATED.

March 3, 1881, dredging	$5,000.00
August 2, 1882, dredging	2,000.00
Total	7,000.00
Amount expended to June 30, 1888	6,928.12

Money statement.

July 1, 1887, amount available	$81.88
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	10.00
July 1, 1888, balance available	71.88
Amount (estimated) required for completion of existing project	16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.

E 13.

IMPROVEMENT OF THE CHANNEL BETWEEN STATEN ISLAND AND NEW JERSEY.

A description of this channel and a complete history of the work done towards its improvement may be found in the Annual Report of the Chief of Engineers for 1887, Part I, page 743.

So far, the improvement has been confined to that part of the channel, about 1¾ miles long, which lies east of Elizabethport, N. J., and at the mouth of Newark Bay. This originally had a depth of only 9½ feet in it at mean low water, while the rest of the channel lying between the shores of Staten Island and New Jersey had a depth of from 14 to 40 feet at mean low water.

The first project for the improvement of this channal was made in 1873. This provided for dredging it to a depth of 16 feet for a width of 150 feet at its shallowest part, and protecting the cut by parallel dikes built along each side of it. The estimated cost of this was $443,210. Fifty thousand dollars of this amount, appropriated in 1874, was spent in 1874–'75 in the construction of 2,237 feet of the south dike opposite Elizabethport.

So much opposition to this plan was exhibited by oystermen and tow-boat men, on the ground that its execution would interfere with their business, that it was decided to modify it, although the orginal plan

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was undoubtedly the best from an engineering point of view. It was decided, therefore, in 1880, to dredge a channel 400 feet wide and only 13 feet deep over the middle 200 feet of its width, leaving it but 12 feet deep over the remaining widths of 100 feet on each side. The estimated cost of this work was $125,705. In addition to this, it was proposed, should it be found necessary, to build four detached dikes along the line of the channel, two on the south and two on the north side, whose estimated cost was $60,000, bringing the total estimated cost of the proposed improvement up to $185,705.

By May, 1883, the channel had been dredged to nearly the proposed width and depth, except at the bend near the Stake Light. But owing to the growing demands of commerce it was subsequently decided to give the channel a low-water depth of 13 feet for its full width of 400 feet, the estimated cost of which was $25,000. This made the total estimated cost of this work $210,000. This deepening and widening was carried on in 1884, 1885, and 1887, until at present there is a channel not less than 400 feet wide and 13 feet deep, or over, east of Shooter's Island, a channel 400 feet wide with the same depth round the Stake Light, and, connecting them, a channel from 300 to 350 feet wide and from 13 to 14 feet deep.

The dredging in progress at the close of the last fiscal year under contract with Mr. Thomas H. Bonton, dated April 15, 1887, was continued up to July 26, 1887, when the contract was closed.

The total amount of material removed under this contract was:

From east of Shooter's Island	cubic yards	22,603
From the bend at the Stake Light	do	22,475
Total		45,078

The commerce of this channel, which is known as the Kills, is so large that the narrow part near the Stake Light constitutes a serious obstruction to it. This part should be widened to 400 feet as proposed, the depth of the widened part to be 13 feet as in the other parts of the channel, and it is recommended that $30,000 be appropriated for this purpose.

There appears to be no present necessity for beginning the construction of the dikes.

From statistics compiled last year, the commerce passing the Stake Light is shown to have a tonnage of 8,442,439 tons, with a value of $67,539,512.

This work is in the collection district of New York, which is the nearest port of entry. Nearest light-house, Bergen Point Light; nearest fort, Fort Tompkins.

Amounts appropriated.

Date.	Application.	Amount.
June 23, 1874	Diking, first project	$50,000
Aug. 14, 1876	Dredging, second project	10,000
June 18, 1878	do	15,000
June 14, 1880	do	29,000
Aug. 2, 1882	do	40,000
July 5, 1884	do	10,000
Aug. 5, 1886	do	15,000
	Total	119,000

Amount expended to June 30, 1888 ..... $168,189.40

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Money statement.

July 1, 1887, amount available	$1,926.25
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,115.65
July 1, 1888, balance available	810.60
Amount appropriated by act of August 11, 1888	15,000.00
Amount available for fiscal year ending June 30, 1889	15,810.60
Amount (estimated) required for completion of existing project	76,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

E 14.

IMPROVEMENT OF RARITAN BAY, NEW JERSEY.

Raritan Bay forms the western part of the large triangular bay inclosed between Sandy Hook, the New Jersey shore, and Staten Island, the eastern part of which is commonly known to New Yorkers as the Lower Bay, as it lies just outside of, or below, New York Harbor, which is the name usually applied to the inner body of water on which the city of New York is situated.

The Raritan River flows into Raritan Bay at its extreme western end, passing between Perth Amboy and South Amboy, and Newark Bay is connected with both the Raritan River and Bay by the Arthur Kill and Staten Island Sound, which, separating Staten Island, belonging to the State of New York, from the New Jersey shore, enters Raritan Bay at Perth Amboy.

The depth of the bay varies from 5 to 30 feet, decreasing gradually towards its western and southern shores.

The natural channel leading out of it, after passing the Great Beds Light at the junction of Staten Island Sound and the Raritan River, does not follow the middle of the bay, but hugs the Staten Island shore for nearly 4 miles to Seguine's Point, situated about half a mile east of Prince's Bay Light; thence it runs southeastwardly towards the inner point of Sandy Hook for about 2 miles, crossing a shoal which puts out towards the southward from the Staten Island shore.

In 1880, before any improvement had been made here by the Government, 18 feet at mean low water could be carried through the channel from Perth Amboy to Great Beds Light, while there was not less than 21 feet of water from Great Beds Light to Seguine's Point; but from Seguine's Point to deep water in the outer bay only 14½ feet of water could be carried across the shoal.

The width of this shoal between the 21-foot curves was about 8,000 feet.

Through the middle of the bay, south of this channel, from Great Beds Light directly towards Sandy Hook, only 11 feet of water could be carried over the shoals.

The above depths all refer to mean low water.

A survey of this bay was ordered in 1880, with the view of ascertaining the practicability of securing a greater depth of water from the main ship-channel in the lower bay to the wharves at Perth Amboy, as vessels were often much delayed in crossing the shoal east of Seguine's Point.

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This survey was made under direction of Lieutenant-Colonel Michler, Corps of Engineers, whose report will be found in the Annual Report of the Chief of Engineers for 1881, Part I, pages 717 to 719.

This report recommended dredging a channel 300 feet wide and 21 feet deep at mean low water from Seguine's Point southeastward to the deeper waters of the bay outside, which would require the removal of—

460,000 cubic yards of materials, which at 25 cents per cubic yard, would cost	$115,000
Contingencies, 10 per cent	11,500
Total estimated cost	126,500

The mean rise and fall of the tide in Raritan Bay is the same as at Sandy Hook, nearly 4.8 feet.

Owing to the reduced scour of the ebb current after leaving Seguine's Point, due to its unfavorable direction, since it crosses the proposed channel at an angle of about 45 degrees, it was not expected that the dredged channel would remain permanently open; but as no other means of obtaining a permanent channel was deemed practicable, the project was accepted and approved.

The first appropriation made for its execution was that of March 3, 1881, $50,000.

Under it the work of dredging was let to the Atlantic Dredging Company, at 28 cents per cubic yard, and operations were begun in October, 1881, and were continued to June 17, 1882, by which time 166,346 cubic yards of material had been excavated, giving a channel through the shoal 21 feet deep and 105 feet wide.

Under date of August 2, 1882, a further appropriation of $50,000 was made.

The contract was again awarded to the Atlantic Dredging Company, at 22 cents per cubic yard, who carried on the work until October 31, 1883, by which time 202,226 cubic yards had been excavated, increasing the width of the channel to 240 feet, except at the western end, where, for 2,000 feet, it had a width of only 200 feet.

By act of July 5, 1884, $20,000 more was appropriated for this work. The Atlantic Dredging Company was again the successful bidder, and a contract was entered into with it, at 16 cents per cubic yard. This contract was closed December 13, 1884. Under it 112,657 cubic yards of material were excavated, of which 2,403 cubic yards were not dumped where required, and were therefore not paid for.

With the appropriations thus far made, 481,329 cubic yards of material had been excavated from the channel.

It was believed, when dredging was closed for the season, that a channel 300 feet wide and 21 feet deep had been obtained across the shoal; but it was not possible to make the survey necessary for determining the actual condition of the work until May, 1885, when it was found that the sides of the cut had run into the channel, giving a depth of 21 feet for most of its length, with lumps in it here and there with but 18 or 20 feet of water over them, the average width being 250 feet.

The latest Coast Survey chart, though not giving soundings so much in detail as our own charts, seems to indicate that there has been a good deal of shoaling where this cut was made, and it is probably true that we have not now the depth there which we gained by dredging.

It is not possible without another detailed survey to state what this amount of shoaling is, but it is probably not less than 100,000 cubic yards.

The original project of 1881 contemplated the excavating of this chan-

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nel only, but Colonel Gillespie in his annual reports of 1883, 1884, and 1885, calls attention to two other shoals in the bay west of Great Beds Light; one in the channel leading up to South Amboy, on the Raritan, and the other leading up to Perth Amboy on Staten Island Sound.

The shoal in the channel leading up to Perth Amboy is a middle ground, having a channel on each side of it, the eastern one being the best; but only from 17 to 19 feet of water can be carried through it at low water. It is also narrow in places and crooked.

Colonel Gillespie recommended, therefore, that a straight channel 300 feet wide and 21 feet deep should be dredged from deep water near Great Beds Light through the east end of this shoal to deep water at Ward's Point, opposite Perth Amboy. This would require the removal of about 150,000 cubic yards of material. (See Report of the Chief of Engineers, 1885, Part I, page 758.)

This, with the 21-foot channel dredged outside of Seguine's Point, would give a continuous 21-foot channel from the main ship-channel in New York Bay to the wharves at Perth Amboy.

In the same report he calls attention to a shoal lying between South Amboy and Great Beds Light, on which there is only 12½ feet of water, and in order to give the large tow-boats running from New York up the Raritan sufficient water he recommends the cutting of a channel through this shoal 4,500 feet long, 300 feet wide, and 15 feet deep. The amount of excavation required to dredge this channel he estimates at 150,000 cubic yards.

The cost of dredging these two channels and restoring the original width in the cut east of Seguine's Point he estimated at $114,000. But as the filling at the latter point is probably much greater than was expected, this estimate will have to be increased, and may be placed at 400,000 cubic yards, which, at 30 cents per cubic yard, would cost $120,000.

Under the appropriation of $37,500 made by act of Congress approved August 5, 1886, proposals were asked for dredging a channel 300 feet wide and 21 feet deep from the 21-foot curve near Ward's Point, past Great Beds Light, towards the 21-foot curve near Seguine's Point, the amount of material to be excavated being 150,000 cubic yards, more or less, depending upon the price bid.

The Atlantic Dredging Company were the lowest bidders at 23¾ cents per cubic yard, and a contract for the work was entered into with them August 2, 1887.

The time set for its completion was November 30, 1887, but owing to bad weather the contract was extended first to May 1, and then to June 15, 1888.

The work was completed in June, when 163,756 cubic yards of material had been excavated, of which 138,451 cubic yards were removed from the channel from Ward's Point to Great Beds Light and 25,305 cubic yards from the channel from Great Beds Light towards Seguine's Point. But 20,000 cubic yards were deducted from the total amount dredged on account of the contractor having dredged below the required depth, leaving the amount actually paid for 143,756 cubic yards.

This gave a channel 300 feet wide and 21 feet deep from the wharves at Perth Amboy to the bend at Great Beds Light and a channel 21 feet deep, 315 feet wide, across the crest of the shoal in the channel leading from the bend towards Seguine's Point, but the funds were not sufficient to complete the work.

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The great shoaling in the channels in Raritan Bay is only partly due to natural causes. The most of it is due to dredged material being willfully and illegally dumped there to save the expense of towing it out to sea. This is a crime against the public welfare that ought to be met with heavy punishment.

The material excavated by the dredges was mostly mud, and in one place compact sand, but in a number of spots the mud brought up was evidently old dredged material which had been deliberately dumped illegally in the channel. It is safe to say that no material privately dredged from the wharves and slips in Raritan Bay is ever dumped anywhere except in the bay. None of it ever passes Sandy Hook.

It is recommended that the entire balance of the amount of money estimated as necessary for the completion of this work, namely, $82,500, be applied to it during the coming year.

This work is in the collection district of Perth Amboy, which is the nearest port of entry. Nearest light-house, Prince's Bay; nearest fort, fort at Sandy Hook.

Amounts appropriated.

Date.	Application.	Amount.
Mar. 3, 1881	Dredging	$50,000
Aug. 2, 1882	....do	50,000
July 5, 1884	....do	20,000
Aug. 5, 1886	....do	37,500
	Total	157,500

Amount expended to June 30, 1888, $153,557.15.

A statement of commerce will be found in my last annual report upon this improvement.

Money statement.

July 1, 1887, amount available		$37,579.03
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$33,636.18	
July 1, 1888, outstanding liabilities	2,935.13	
		36,571.31
July 1, 1888, balance available		1,007.72
Amount appropriated by act of August 11, 1888		25,000.00
Amount available for fiscal year ending June 30, 1889		26,007.72
Amount (estimated) required for completion of existing project		57,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		57,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for dredging Raritan Bay, New Jersey, opened at the U. S. Engineer Office, Army Building, New York, July 20, 1887, at 12 o'clock m., under advertisement of June 23, 1887.

No.	Name and residence of bidders.	150,000 cubic yards.	
		Rate per cubic yard.	Amount.
		Cents.	
1	Morris Cumings Dredging Company, New York, N. Y.	24½	$36,750
2	American Dredging Company, Philadelphia, Pa	26	39,000
3	Thomas Potter, Jersey City, N. J.	26	39,000
4	Atlantic Dredging Company, Brooklyn, N. Y.	23½	35,625
5	P. Sanford Ross, Jersey City, N. J.	24½	36,750

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Abstract of contract entered into during the fiscal year ending June 30, 1888.

Name of bidder.	Date.	Purpose.	Price per cubic yard.	Amount.
Atlantic Dredging Company...	Aug. 2, 1887	Dredging 150,000 cubic yards ...	Cents. 23½	$35,625

E 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

SLOOP LOCOMOTIVE, HUDSON RIVER, NEW YORK.

This sloop, of about 90 tons burden, sunk in the Hudson River off Tivoli, opposite Saugerties, N. Y., August 5, 1887, in about 43 feet of water, but as her mast and boom were above water it was a dangerous obstruction to navigation.

By authority of the Chief of Engineers it was removed by hired labor October 28, at a cost of $317.94.

BARK QUICKSTEP, NEW YORK HARBOR.

This bark, of about 800 tons burden, sugar laden, was wrecked in the summer of 1887 on the west bank of the main ship-channel, New York Harbor, near Buoy 11.

Under authority from the Chief of Engineers, circular letters were issued for its removal October 15, 1887, and were opened October 26.

Only one bid was received, that of W. E. Chapman; who offered to remove the wreck for $3,200. This offer was accepted and a contract was entered into with him November 5, 1887.

Owing to bad weather, the time for the completion of the contract had to be extended and the work was not satisfactorily completed till May 28, 1888, when the contract was closed.

Abstract of bids for removing the wreck of the bark Quickstep, lying on the edge of the west bank, New York Harbor, opened at the U. S. Engineer Office, Army Building, New York, October 26, 1887, at 12 o'clock, m., under circular letter of October 15, 1887.

No.	Name and residence of bidder.	Amount.
1	William E. Chapman, New York City	$3,200

Abstract of contracts entered into during the fiscal year ending June 30, 1888.

Name.	Date.	Purpose.	Amount.
William E. Chapman	Nov. 5, 1887	Removing wreck of bark *Quickstep*	$3,200

WRECK OF A CANAL-BOAT IN HARLEM RIVER, NEAR HIGH BRIDGE.

Under authority of the Chief of Engineers, circular letters were issued, asking bids for its removal, on November 29, and opened December 8, 1887.

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The lowest bidder was the Baxter Wrecking Company, and a contract for its removal was entered into with them December 23, 1887.

Work commenced in December, 1887, and was completed January 20, 1888.

Abstract of bids for removing the wreck of a canal-boat lying in the Harlem River near the High Bridge, opened at the U. S. Engineer Office, Army Building, New York, December 8, 1887, under circular of November 29, 1887.

No.	Name of bidders.	Amount.
1	Baxter Wrecking Company, New York City	$175
2	William E. Chapman, New York City	190
3	Edward R. Lowe, New York City	449

Abstract of contracts entered into during the fiscal year ending June 30, 1888.

Name.	Date.	Purpose.	Amount.
Baxter Wrecking Company..	Dec. 23, 1887	Removing wreck of canal-boat	$175

E 16.

PRELIMINARY EXAMINATION OF SPRING CREEK, NEW YORK.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 5, 1888.

SIR: I have the honor to submit herewith a copy of a report to this office from Lieut. Col. Walter McFarland, Corps of Engineers, of the results of the preliminary examination of Spring Creek, New York, made to comply with the requirements of section 6 of the river and harbor act of August 5, 1886.

The imperfect description in the act of the locality of this stream, which has but recently been ascertained, has delayed this examination.

Concurring in the opinion of the local engineer, that Spring Creek is not worthy of improvement by the General Government, I have not directed an additional survey to be made.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

HON. WILLIAM C. ENDICOTT,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL WALTER M'FARLAND, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., December 30, 1887.

GENERAL: I have the honor to submit the following report upon the preliminary examination of Spring Creek, New York, made under the instructions of your letter of the 17th instant.

Spring Creek, New York, is a narrow, crooked, and shallow tidal stream, 3 or 4 miles long, flowing from the vicinity of East New York

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and the twenty-sixth ward of Brooklyn southerly into Jamaica Bay on the south shore of Long Island. It is called Old Mill Creek on the Coast Survey chart.

Its navigation is closed about a mile above its mouth by a dam. Its channel is about 40 feet wide, and it is claimed that it is 3 feet deep at low water, but the depth in the bay at the mouth of the creek at low water is less than a foot.

The rise of the tide is about 5 feet, and vessels of this draught can at high water run up to the dam and the bulkhead near it built by the city of Brooklyn.

It is desired that the creek shall be straightened and the channel deepened to 4 feet at mean low water, when, it is believed by those interested in its improvement, nearly all of the coal and building materials needed by this large and rapidly growing part of the city of Brooklyn, which now is brought by drays and rail from the East River, from 7 to 9 miles distant, would be brought by this water-route.

At present the creek has no commerce, with the exception of an occasional sloop-load of manure or coal brought in, and nothing is sent out.

Under the circumstances, while it is doubtless very desirable, on account of local interest, that this water-way to the twenty-sixth ward of Brooklyn should be opened, it appears to me that this is the duty of the city or of the county concerned, rather than that of the General Government, since no public necessity or convenience of commerce would be subserved by it.

I have to report, therefore, that I do not consider Spring Creek, New York, worthy of being improved by the General Goverment.

I transmit herewith a copy of the report of G. W. Kuehnle, who was detailed to make the examination.

Very respectfully, your obedient servant,

WALTER MCFARLAND,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. G. W. KUEHNLE.

NEW YORK, *December* 23, 1887.

SIR: I have the honor to submit the following report of an examination of Spring Creek, New York, made December 22, in compliance with your verbal orders of December 21, 1887.

Spring Creek (called Old Mill Creek on Coast Survey chart of Jamaica Bay) is a tributary of Jamaica Bay and it is the nearest approach by water to East New York and the twenty-sixth ward, Brooklyn. The course of the creek is through salt marsh, and has several very sharp bends in it. At the head of navigation there are an old dam and tide mill (built in 1810) owned by J. L. Van Wicklen, a small hotel owned by D. L. Van Wicklen, and an old bulkhead owned by the city of Brooklyn. The distance from the head of navigation to the mouth of the creek is less than a mile, and the least depth about 1 foot at low water. The depth in the bay near the mouth of the creek as shown on the Coast Survey chart, 1879, is three-fourths foot, but Mr. Van Wicklen claims that vessels can carry 3 feet to the mouth. The improvement desired is to have the creek straightened by cutting off two of the bends (which appear to hinder navigation as much as the want of depth), the channel widened to 60 feet (the present width being about 40 feet for part of the creek), and a channel dredged to 4 feet at low water from the Old Mill Landing to deep water in Jamaica Bay.

The present commerce of the creek is practically nothing, consisting of an occasional sloop-load of manure or coal for the neighboring truck farmers. At the time of the building of the Brooklyn water-works most of the material used on two sections of the work was brought to the Old Mill Landing. There are quite a number

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of small boats at the head of the creek that are nearly all used by pleasure-seekers in the summer.

It is evident from the numerous new buildings in the course of erection and other visible signs of improvement that this section of Brooklyn is rapidly developing.

It is claimed, by those interested, that by improving the creek all the coal and building material used in the vicinity and coal used by the Brooklyn and Long Island Water-works would be shipped by water to Old Mill Landing. The present means of getting these supplies is by trucking from Brooklyn (a distance of 7 miles) and by Long Island Railroad in a round-about manner from Hunter's Point *via* Jamaica. It seems to me that the effect of the improvement is greatly overestimated by the promoters, since, if the route were a profitable one, the present depth at high water (about 6 feet) would be sufficient for light-draught vessels and canal-boats, and there is no evidence that any such vessels use the creek, excepting the very occasional ones loaded with manure or coal for a near-by truck farmer. There is no outgoing freight, as there are no factories or mills in the vicinity.

I was not able to find any one that could give me any figures in regard to the amount of material that would be expected to come by way of the creek, but have been promised that such statistics will be forwarded to you in a few days.

Taking into consideration the fact that the benefit, if any, would be a purely local one, and not to the advantage of general commerce, and that it is extremely doubtful if an improvement of the channel would increase the traffic, I can not report that Spring Creek is worthy of improvement.

The cost of a survey and map would not exceed $150.

The cost of the improvement can not be given with any accuracy without a survey, but ought to be less than $10,000.

Very respectfully, your obedient servant,

G. W. KUEHNLE.

Lieut. Col. WALTER MCFARLAND,
Corps of Engineers, U. S. A.

E 17.

PRELIMINARY EXAMINATION OF HUDSON RIVER, NEW YORK, BETWEEN NEW BALTIMORE AND COXSACKIE.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., February 28, 1887.

GENERAL: I have the honor to submit the following report upon the preliminary examination of the "Hudson River between New Baltimore and Coxsackie," authorized by act of Congress approved August 5, 1886.

The only map of this part of the Hudson River which we have among our records is one made by the Coast Survey about thirty years ago. Several surveys of the upper part of the river have been made by the War Department under authority of law, but these extend only from Troy, at the head of navigation, down to New Baltimore. The part of the river included in the examination now under discussion extends from New Baltimore down-stream to Coxsackie, a distance of 6 miles, and the greatest changes which have been discovered are in the lower third of this stretch.

Above Coxsackie, and within 2 miles of it, are two islands, one below the other, which separate the river here into two channels, the easterly one being the widest, deepest, and the most used.

The upper one of these islands is known as Rattlesnake or Light-house Island, and has on it the Coxsackie light-house, and a large ice-house with its necessary quarters and stables. The lower island is called Coxsackie Island, and has on it three large ice-houses. Both of these islands are overflowed during freshets.

The present examination shows that the shore and channel lines as given in the Coast Survey chart before referred to have very much al-

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tered. The eastern side of Rattlesnake Island and the head of Coxsackie Island have been largely washed away, while the lower end of Coxsackie Island has been built up and now extends several hundred feet farther down-stream than it did formerly.

The channel has shifted its position and has shoaled in places. This deterioration of the channel will continue until it is stopped by some such works as those which have been built between Troy and New Baltimore for the purpose of regulating the channel; but before any such works can be undertaken a thorough survey of this part of the river must be made, and this should extend from Stone House Bar, just below New Baltimore, down to Fordham Point, a little below Coxsackie. Such a survey would cost about $2,500.

In my judgment the survey and improvement of this part of the Hudson River are quite as important as the survey and improvement of the part which lies above it—between New Baltimore and Troy—upon which hundreds of thousands of dollars have been expended, and by which the whole commerce of the Hudson River and of the Erie Canal are affected.

Very respectfully, your obedient servant,

WALTER MCFARLAND,
Lieut. Col. of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

SURVEY OF HUDSON RIVER, NEW YORK, BETWEEN NEW BALTIMORE AND COXSACKIE.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., March 29, 1888.

GENERAL: I have the honor to submit the following report, with illustrative chart, upon the survey of the Hudson River, between "New Baltimore and Coxsackie," authorized by act of Congress, approved August 5, 1886, and made under the direction of Lieut. Col. Walter McFarland, Corps of Engineers, in local charge of the improvement of the Hudson River, in accordance with Department instructions dated March 16, 1887.

A preliminary report was made by that officer February 28, 1887, to which I respectfully invite attention.

The accompanying report of Mr. Maurice Kingsley, assistant engineer, who personally conducted the survey, gives the details of the extent of the survey, and a general comparison of the present condition of this reach of the river with that existing at the time of the survey by the Coast Survey in 1856. During the thirty years which have elapsed since the survey of 1856, only a few changes have occurred in the channel-way along the reach under consideration, and these have been so slight as not to affect the convenience of its navigation. The upper ends of Light-House and Coxsackie islands have been wasted partially by the currents, and the shoal at the lower end of the latter island has made to the southward, though its extension in that direction is restricted by the frequent passage of the boats to the Coxsackie Landing. The survey indicates that the channel over Stone-House Bar, adjacent to New Baltimore, has 12 feet depth of water, where only 11 feet existed in 1856. This increase is due probably to the dredging operations which were conducted at this point by the State in 1883–'84 (page 696, Annual Report Chief of Engineers, 1884, part 1).

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The office of the State engineer contains no records of this work, so that it is impossible to give the condition of the bar at the time work began, and the degree to which it was improved by the State.

The project approved by the War Department, 1867, for the improvement of the Hudson River, provides for a navigable channel 11 feet deep between Albany and New Baltimore. An inspection of the accompanying map shows that more than this depth exists everywhere from New Baltimore to Coxsackie in a wide and convenient channel following the east bank, and since the navigation between these two points is easier and more convenient than it is above, I concur with Mr. Kingsley in the statement that it does not appear to be necessary to make any improvement at the present time between New Baltimore and Coxsackie. If it is discovered later that material washed from the heads of Light-House and Coxsackie islands is transported by the currents to the bar at the lower end of Coxsackie Island, causing the channel depths to be diminished there to the obstruction of commerce, it may be expedient to revet the heads of those islands in a permanent way.

This part of the Hudson River is in the collection district of New York, and the nearest light-houses are located at Stuyvesant and Coxsackie. The nearest port of entry is New York.

Very respectfully, your obedient servant,

G. L. GILLESPIE,
Lieut. Col. of Engineers,
in temporary charge.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. MAURICE KINGSLEY, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
New York, N. Y., March 28, 1888.

COLONEL: I respectfully submit the following report, with a map, upon the survey of the Hudson River between New Baltimore and Coxsackie, N. Y., ordered by letter of the Chief of Engineers dated March 16, 1887, and made in accordance with river and harbor act of August 5, 1886, after a preliminary examination had been reported upon.

The survey was made from September 19 to November 30, 1887, and embraced 6 miles of the river, from Fordham Point, 1 mile below Coxsackie Landing, up to the lower part of New Baltimore, and connecting there with Assistant Engineer R. H. Talcott's survey of 1884, made under direction of Capt. James Mercur and Lieut. Col. Walter McFarland, Corps of Engineers.

The primary triangulation points occupied were those permanently located by the State of New York in 1880, and which checked out accurately; from these the sounding points used in the survey were located. The shore-lines were run in by an ordinary transit line, checked at all important points with the primary triangulation stations and sounding points.

Soundings were taken with an 11-foot rod, marked in feet and tenths, to which a 7-fathom sounding-line was attached, similar to those in use on the Mississippi; as, on account of the sudden changes in depths and heavy currents, the ordinary rod or lead-line could not be used to advantage. Each sounding was located by two transits on shore.

The soundings from Coxsackie to Stuyvesant Light were referred to a gauge set up on the light-house crib at Coxsackie, the zero of which was referred to a Coast Survey bench-mark established in 1856 directly across the river at Stuyvesant, and on which Assistant Engineer R. H. Talcott checked in running his levels from Albany in 1876 and 1884.

There are no records to show that the Coast Survey plane of 1856 was accurate. Assistant Talcott has at various times gone extensively into this question and informs me that it was impossible to compare the two planes; but that, in his opinion, they were nearly coincident.

The soundings taken from Stuyvesant Light to New Baltimore during the present survey were referred to a bench-mark at New Baltimore, also established by the Coast Survey, and connected with Assistant Talcott's lines of levels; and for which no Coast Survey data can be procured.

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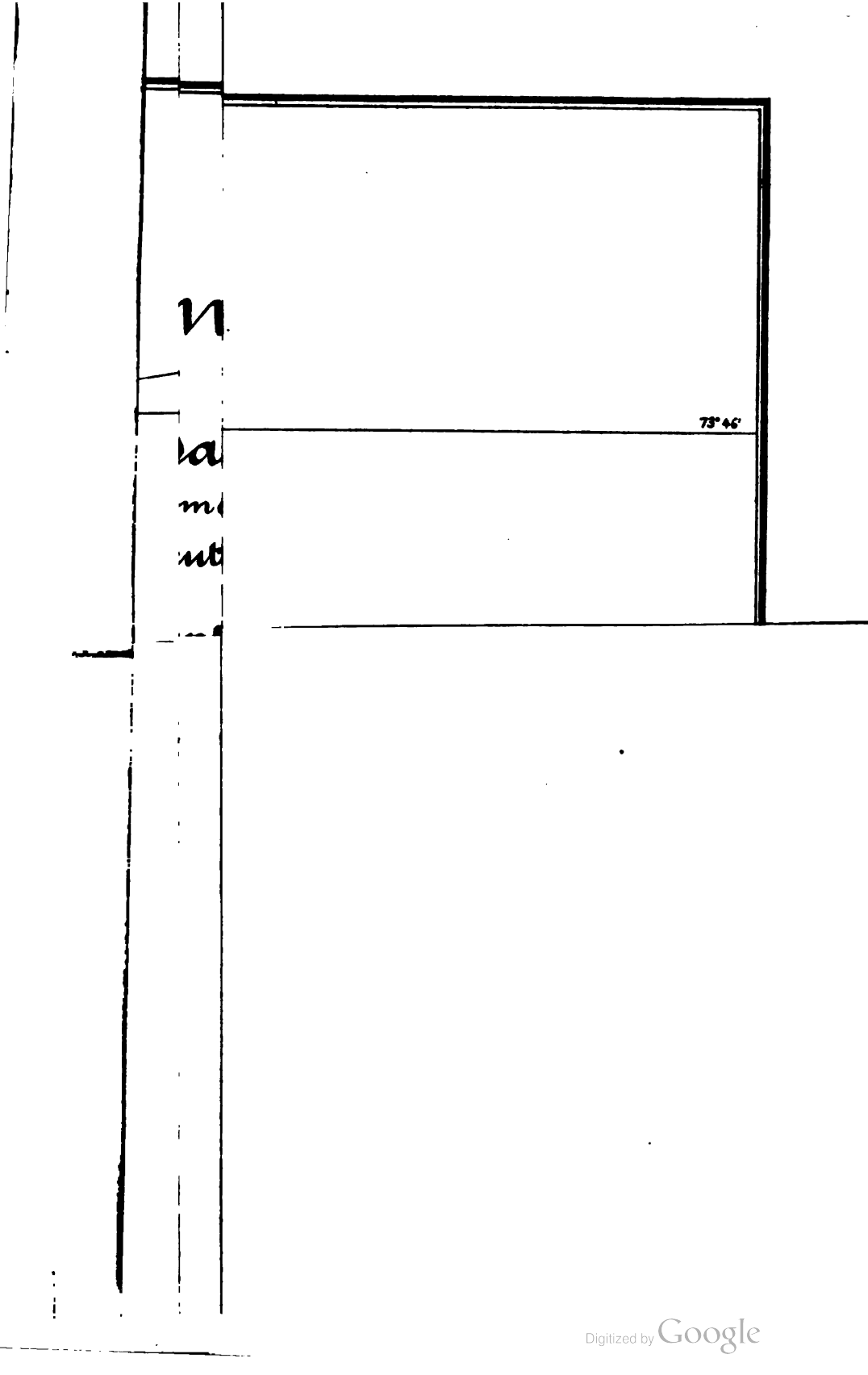

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However, at Castleton, 5.7 miles above New Baltimore, Assistant Talcott was able to make a direct comparison with his levels of 1876 and the Coast Survey plane, which showed his plane to be 0.117 feet *below* the Coast Survey plane, so that it is not likely that the planes on the river below Castleton vary very much.

The results of two and a half months' gauge-readings at Coxsackie Light during the survey of 1887 give a mean rise and fall of 3.7 feet.

Mr. Talcott's records from June 19 to November 14, 1876, give a mean rise and fall of 3.66 feet; while the Coast Survey records from August 13, 1856, for the remainder of the season give a mean rise and fall of 3.8 feet.

It is well to notice, however, that, owing to extreme low water during the survey, mean low water was 0.6 foot *below* the plane of reference used.

The highest tide recorded above the plane of reference during the survey was 4.50 feet and the lowest 2 feet below; both of these were due to heavy winds.

The channel to the westward of Bronx Island is so shoal that only cross-sections were taken at intervals across it. No commerce goes up and down this channel.

A comparison between the last Coast Survey chart of this part of the river, dated 1856, and the present survey show that very slight changes have taken place in the channel, assuming that there is only 0.1 foot difference in the two planes, as at Castleton.

For the first mile below New Baltimore across Stone House Bar the channel shows a slight improvement, there being at present a narrow 12-foot channel about 100 feet wide as against an 11-foot channel in 1856. The Coast Survey chart is on too small a scale to make an accurate comparison of the 11-foot curves, but they appear to be about the same, 250 feet apart in the narrowest place.

It is probable that the 12-foot channel is due to dredging done by the State of New York in 1883–'84, when 23,238 cubic yards of material were removed from the channel, according to the annual report of Capt. James Mercur, Corps of Engineers. There are no records on file in the State engineer's office at Albany of this dredging, and it is not known what depth or width of channel was obtained.

Below Stone House Bar the channel is wide for 3 miles and varies from 17½ to 40 feet in depth down to a shoal putting out from the east side of Coxsackie Island. Over this there is a good 13-foot channel, as against a 12-foot channel in 1856. Below this there is a good channel, with an average depth of 24 feet of water down to the southernmost point of the survey. The bar on the east of Coxsackie Island has made outward, and it is more than probable that this contraction of the channel has created scour enough to increase the depth.

The only trouble with this bar is that it occurs at a sharp bend in the channel and any stranger is liable to run too close to it, especially as the black buoy marking its eastern extremity was during the survey placed too far to the westward.

The shoal at the lower end of Coxsackie Island is making southward, but a channel is kept open by the steamboat companies running to Cocksackie, so that the southern extremity of the shoal is no further south than in 1856.

The main channel, therefore, between New Baltimore and Cocksackie may be said to be in better condition than in 1856.

The project approved in 1867 for the improvement of the Hudson River between Albany and New Baltimore proposed to give a navigable channel 11 feet deep between those two points. This depth has been obtained in 1885, with a few exceptions.

The commerce between Albany and New Baltimore is precisely the same as that between New Baltimore and Coxsackie, and navigation between the two latter points is very much easier than between the two former, owing to the greater widths of channel and greater depth of water; it, therefore, does not appear necessary to make any improvement between New Baltimore and Coxsackie at present.

The heads of Light-House and Coxsackie islands are wearing away, and also their eastern sides about half way down from the heads; but these islands are private property, and it does not appear that the débris carried away from them affects the channels at present.

It may become necessary to improve Stone House Bar from time to time by dredging, as I learned that ice gorges formed there sometimes in the spring. A permanent improvement of this bar could be made by building a dike on the western side from near Horton's ice-house.

This would be about 3,000 feet long; but there appears no present necessity for it.

A full statement of the commerce of the Hudson River over the improved portion may be found in Annual Report of the Chief of Engineers for 1887, page 657. This shows the commerce to be 6,671,875 tons, valued at $250,213,049 in 1886, and the commerce of the Hudson between New Baltimore and Coxsackie will vary very little from this.

Respectfully submitted.

MAURICE KINGSLY,
Assistant Engineer.

Lieut. Col. G. L. GILLESPIE,
Corps of Engineers.

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APPENDIX F.

IMPROVEMENT OF RIVERS AND HARBORS IN NORTHERN NEW JERSEY AND OF THE HARBOR OF KEYPORT.

REPORT OF CAPTAIN GEORGE McC. DERBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Passaic River, New Jersey.
2. Elizabeth River, New Jersey.
3. Rahway River, New Jersey.
4. Woodbridge Creek, New Jersey.
5. Raritan River, New Jersey.
6. South River, New Jersey.
7. Cheesequakes Creek, New Jersey.
8. Keyport Harbor, New Jersey.
9. Matawan Creek, New Jersey.
10. Shrewsbury River, New Jersey.
11. Manasquan River, New Jersey.

ENGINEER OFFICE, U. S. ARMY,
New York, July 9, 1888.

GENERAL: I have the honor to transmit herewith my annual reports on the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1888.

Very respectfully, your obedient servant,

GEO. McC. DERBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

F 1.

IMPROVEMENT OF PASSAIC RIVER, NEW JERSEY.

The Passaic River is being improved under two separate projects, the first applying to the river above Centre Street Bridge, Newark, as far as Passaic, a distance of 8 miles; the second to the lower course of the river, from the Centre Street Bridge to beyond the shoals in Newark Bay, a distance of 7⅝ miles.

1. ABOVE NEWARK.

Before its improvement was undertaken the upper part of the river had a navigable 6-foot channel except at Middle Belleville, Rutherford

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Park, and Holzman's bars, where the depths were 4.5 feet, 3.9 feet, 3 feet, and 3.5 feet respectively.

The project of improvement was adopted in 1872, and provided for a channel across the above shoals from 7½ to 6 feet deep at mean low water, and from 200 to 50 feet wide, to be obtained by dredging and diking, at a cost of $123,924. It was modified in 1885 by extending the channel below Middle Bar 1,500 feet to the Erie Railroad Bridge, increasing the estimate to $129,000.

Under this project $123,762.04 had been expended to June 30, 1887, and channels of the required depth had been dredged from 60 to 75 feet wide, excepting for a distance of 1,500 feet above the Erie Railroad Bridge.

There has been no work done on the upper river during the fiscal year, no efficient means of applying the small allotment of $2,250, made by the act of August 5, 1886, having been found. The condition of the river remains unchanged.

The population of the townships on the Passaic above Newark, including the city of Paterson, was returned in 1885 as 114,726, and the commerce of the upper river was valued in 1884 at $1,032,000. Returns representing less than one-half the firms along the river show for the year 1887 commerce of 53,000 tons, valued at $721,119. The number of vessels passing the Centre Street Draw-bridge during the year 1887, has been 10,040, compared with 9,485 in 1886, and 6,271 in 1879.

The expenditures for the fiscal year amount to $345.50 for draughting (old records) and administration.

The balance of the estimate, $7,512, can be expended profitably, as regards the efficient prosecution of the work, during the fiscal year ending June 30, 1890; and, if appropriated, will be expended in dredging the channels to the dimensions required by the project.

The estimated amount required for completion of the existing project is $7,512.

Passaic River is in the collection district of Newark, which is the nearest port of entry. Nearest light-house, Passaic Light, at the lower end of the dike in Newark Bay. Fort Tompkins is the nearest fort.

Amount of revenue collected during the fiscal year ending June 30, 1888, $2,613.62.

Original estimate (1872)	$123,924.00
Revised estimate (1886)	133,762.00
Amount appropriated	126,250.00
Amount expended	124,107.54

Money statement.

July 1, 1887, amount available	$2,487.96
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	345.50
July 1, 1888, balance available	2,142.46
Amount appropriated by act of August 11, 1888	7,500.00
Amount available for fiscal year ending June 30, 1889	9,642.46

2. PASSAIC RIVER BELOW NEWARK.

The lower portion of the river, from the Centre Street Bridge to Newark Bay, was first surveyed by the Engineer Department in 1879. The greatest depth in the channel at a point above the Elbow Beacon was only 7.1 feet, and in many places the greatest depth was 7.5 feet at mean low water.

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A project was adopted, based on this survey, providing for obtaining, by diking and dredging, a channel 200 feet wide and 10 feet deep at mean low water, from the Centre Street Bridge to Newark Bay, at a cost of $232,875.

This project was modified in 1884, pursuant to the river and harbor act of that year, providing for extending the dike at the mouth of the river into the bay, a distance of 8,000 feet, and for dredging a channel across the shoal in Newark Bay 200 feet wide and 10 feet deep at mean low water, increasing the original estimate to $353,875.

June 30, 1887, $149,223.60 had been expended under this project; the dike at the mouth had been extended about 1,700 feet, making a total length of 5,705 feet; the channel through the shoal in the bay had been dredged to the required dimensions, as also the channel up the river as far as the Newark and New York Railroad Bridge. The remainder of the distance to the Centre Street Bridge the 10-foot channel had only been dredged from 130 to 100 feet in width. These results had been of very great benefit to the large commerce of the river, which was estimated in 1884 at 1,200,000 tons, valued at $30,000,000.

The contract of October 25, 1886, with P. Sanford Ross, for the construction of about 1,500 feet of dike, in prolongation of the dike at the mouth of the river, had been extended ninety days at the close of the last fiscal year. The contractor continued work until September 7, 1887, when the contract was closed; 500.3 feet of dike were constructed during the fiscal year, making the total length constructed under the contract 1,500.3 linear feet, and the entire length of the dike 6,205 feet; its projected length is 12,000.

As the survey of 1887, a map of which will be found in the Annual Report of the Chief of Engineers, 1887, page 766, shows that the channel dredged across the shoal in the bay in 1884 is maintaining itself well, it will not be advisable to extend the dike beyond the length now constructed until positive evidence is obtained that it is necessary for the maintenance of the channel, as the dike will set in motion large quantities of material above the shoal, which may give trouble before reaching another suitable resting place.

Should some contraction ultimately be required at this point, it is probable that it could more advantageously be obtained by preventing the scattering of the current of the Hackensack, by a training-dike on the easterly side of the channel, as the long straight bank of the flat on the west side already in a measure serves the purpose of the dike on that side.

Considerable shoaling has taken place in the dredged channel above the curve in the dike, where there is no longer a 10-foot channel for a distance of about 3,500 feet; at the shoalest point the depth is 9.4 feet; there are also three short breaks in the channel farther up, with least depths of 9.6, 9.6, and 9.2 feet. No complaints from navigators have, however, been received as yet of any of these points, or of the lower shoal in the bay.

The expenditures for the fiscal year amount to $19,484.25, as follows:

Dike construction and inspection	$17,405.45
Survey of 1887	1,153.37
Draughting (old records and new work)	411.05
Administration	514.38
Total	19,484.25

There has been no material change in the commerce of the river, which is estimated at 1,000,000 tons annually; 22,742 vessels passed the

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draw-bridge at the mouth during 1887, as compared with 21,234 in 1886.

Newark has a population of over 150,000, and is one of the principal manufacturing cities in the United States.

The amount that can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, is $100,000, and, if appropriated, it will be applied to widening the channel to the dimensions provided by the project, and to the construction of the dikes required in the river.

The estimated amount required for the completion of the existing project is $181,875.

Passaic River is in the collection district of Newark, which is the nearest port of entry. Nearest light-house, Passaic Light, at the lower end of the dike in Newark Bay. Fort Tompkins is the nearest fort.

Amount of revenue collected during the fiscal year ending June 30, 1888, $2,613.62.

Original estimate (1879)	$232,875.00
Revised estimate (1884)	353,875.00
Amount appropriated	172,000.00
Amount expended, including outstanding liabilities July 1, 1888	168,886.85

Money statement.

July 1, 1887, amount available		$4,895.40
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$160,325.00	
July 1, 1888, outstanding liabilities	179.00	
		1,782.25
July 1, 1887, balance available		3,113.15
Amount appropriated by act of August 11, 1888		27,500.00
Amount available for fiscal year ending June 30, 1889		30,613.15

Amount (estimated) required for completion of existing project	154,375.00
Amount that can be profitably expended in fiscal year ending June 30, 1890 submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	100,000.00

F 2.

IMPROVEMENT OF ELIZABETH RIVER, NEW JERSEY.

This stream, which is 2⅝ miles from its mouth to the head of navigation, at Broad street, Elizabeth, has a width of from 50 to 90 feet, and before its improvement the wharves in the city could only be reached at high water by vessels drawing less than 4 feet. Its commerce was estimated at 45,000 tons annually. The range of the tide was about 4.7 feet at its mouth and 3.4 feet at Bridge street.

The project for the improvement was adopted in 1878, and provides for obtaining by dredging a channel 60 feet wide and 7 feet deep at high water, from the mouth of the river to the head of navigation, at an estimated cost of $25,530.

The amount expended under this project to June 30, 1887, was $26,708.66, and a channel has been dredged to the required depth to within 1,000 feet of the Broad Street Bridge. A slight increase in the commerce of the stream had been observed.

There has been no appropriation for this work since 1882, and the expenditures during the last fiscal year have been $13.08 for office expenses.

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The condition of the river has deteriorated since work was suspended. When last examined, vessels drawing 5 feet could ascend the river to the head of the dredged channel at high tide. The commerce of the river is about 30,000 tons, but no substantial increase can be expected while the river remains in its present condition. A coal-yard established last year has done a business of about 6,000 tons.

The city of Elizabeth has a population of about 33,000, and does an active commerce over two important lines of railroad, a considerable portion of which would take the water route to great advantage if adequate facilties existed. It is stated that the establishment of the coal yard on the river has reduced the retail price of coal 50 cents per ton.

If it is the intention of Congress to complete this improvement the balance of the estimate, $16,160, could be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and would be applied to dredging the channel to the full dimensions required by the project.

The estimated amount required for the completion of the improvement is $16,160.

Elizabeth is in the collection district of Newark, N. J.; nearest light-house, Newark Bay; nearest fort, Fort Tomkins.

Amount of revenue collected at the port of Newark, N. J., during the fiscal year ending June 30, 1888, $2,613.62.

Original estimate (1878)	$25,530.00
Revised estimate (1882)	43,160.00
Amount appropriated	27,000.00
Amount expended	26,721.74

Money statement.

July 1, 1887, amount available	$291.34
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	13.08
July 1, 1888, balance available	278.26
Amount (estimated) required for completion of existing project	16,160.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	16,160.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

F 3.

IMPROVEMENT OF RAHWAY RIVER, NEW JERSEY.

In its original condition the Rahway River had a depth of 8 feet and more at mean high water from its mouth to Bricktown, $3\frac{5}{8}$ miles; 7 feet to Edgar's Dock, $4\frac{1}{8}$ miles; 4.4 feet to Milton Avenue Bridge, $4\frac{3}{4}$ miles; and 4 feet to Main Street Bridge, 5 miles, in the town of Rahway. Its commerce was estimated at 120,000 tons, and three attempts had been made to establish a line of steam-boats on the river, but had failed on account of the bad condition of the stream.

The original project for its improvement was adopted in 1878, and provided for dredging a channel 125 feet wide and 8 feet deep at high water from Bricktown to Milton Avenue Bridge, and 100 feet wide from that point to Main Street Bridge. The tide rises about 5 feet at the mouth and 4 feet at the head of navigation.

June 3, 1887, $36,918.13 had been expended under this project, which had resulted in the formation of a channel 7 feet deep at high water,

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and from 100 to 50 feet in width to within 550 feet of the head of navigation; it has not, however, proved permanent.

The commerce of the river had not increased, though freight rates to Rahway had been materially reduced as a result of the improvement of the river.

There has been no appropriation for this work since 1882, and the expenditures during the last fiscal year amounted to $14.20 for office expenses.

The condition of the river has deteriorated since work was suspended and its commerce has decreased, the shoaling of the river having obliged one of the principal shippers to transfer his business to the railroad.

The town of Rahway has a population of about 7,500 people, has a number of manufactories, and ships and receives by rail large quantities of freight annually. The river reaches the center of the town, and if it were in good navigable condition would carry a large trade.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $29,250, could be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and would be applied to deepening and widening the channel by dredging.

The estimated amount required for the completion of the improvement in accordance with the approved project is $29,250.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. The nearest light-house is Prince's Bay Light, and Fort Tompkins is the nearest fort.

Amount of revenue collected during the fiscal year ending June 30, 1888, $56,727.64.

Original estimate (1878)	$36,653.00
Revised estimate (1882)	66,250.00
Amount appropriated	37,000.00
Amount expended	36,932.33

Money statement.

July 1, 1887, amount available	$81.87
July 1, 1888, amount expended during fical year, exclusive of liabilities outstanding July 1, 1887	14.20
July 1, 1888, balance available	67.67
Amount (estimated) required for the completion of existing project	29,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	29,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

F 4.

IMPROVEMENT OF WOODBRIDGE CREEK, NEW JERSEY.

In its original condition this stream was obstructed at its mouth by a bar having a depth of 9.8 feet on its crest at high water, and by two shoals just inside the mouth; from these shoals a good 12-foot channel existed to above Anderson's Brick Works, seven-eighths of a mile from the mouth, above which point, however, many shoals occurred, though a narrow 8-foot channel existed as far as Salamander Dock, 1⅞ miles from the mouth.

The town of Woodbridge, and numerous fire-brick, tile, and drain-pipe works, situated on the creek, did a considerable trade, estimated at 126,000 tons annually. The range of the tide is about 5 feet.

The project for improving the creek was adopted in 1878, and provides for obtaining by dredging and diking a channel 80 feet wide and

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12 feet deep at mean high water from the mouth to Salamander Dock, at an estimated cost of $13,800, increased in 1884 to $29,000.

The amount expended under this project to June 30, 1887, was $19,000, with which the required dike had been constructed, and a 12-foot channel, from 80 to 25 feet wide, had been obtained as far as Valentine's Dock, $1\frac{5}{8}$ miles, and a 9-foot channel 80 feet wide thence to Town Dock, 1,200 feet further up; and the creek was also widened 20 feet at the elbow opposite Salamander Dock.

No increase in the commerce of the creek had been observed.

There has been no appropriation for this work since 1882; there were no funds available during the last fiscal year, and no expenditures. The condition of the channel has deteriorated since work was suspended, and shoals are complained of both above and below Valentine's Dock.

There has been no increase in the amount of commerce reported above, which is already very large in proportion to the size of the stream.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $10,000, can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and would be applied to dredging the channel to the dimensions required by the project, which would add materially to existing facilities. The estimated amount required for the completion of the improvement is $10,000.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house, Great Beds Light, in Raritan Bay. Nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate (1878)	$13,809.14
Revised estimate (1884)	29,000.00
Amount appropriated	19,000.00
Amount expended	19,000.00

Money statement.

Amount (estimated) required for completion of existing project	$10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statistics relative to commerce of Woodbridge Creek, N. J., during the calendar year 1887, were compiled in this office by Mr. C. S. Kelsey, surveyor:

Articles.	Tons.	Value.
Exports.		
Clay and sand	68,140	$167,436
Fire-brick, hollow brick, tile, etc	35,950	291,362
Total	104,090	458,798
Imports.		
Clay	20,000	25,000
Coal, building material, etc	2,552	10,600
Total	22,552	35,600
Total commerce	126,642	494,398

There is no material increase in the traffic by water, the increase in manufactures and the clay output being deflected by better railroad facilities. The shipments by rail of brick, tile, and clay during 1887 amounted to 86,240 tons, valued at $321,015, being two-thirds that shipped by water.

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F 5.

IMPROVEMENT OF RARITAN RIVER, NEW JERSEY.

Before its improvement by the United States, the Raritan River had a depth of 8.5 feet at "The Stakes," 3 miles; of 6.5 feet at the "Middle Grounds," 4½ miles; of 7.5 feet at Whitehead's Sand Dock, 8½ miles; and between this point and New Brunswick, 12¼ miles above the mouth, the channel was obstructed by a number of rocky shoals with depths of from 8.4 feet to 6.9 feet at mean low water. The city of New Brunswick and the Delaware and Raritan Canal which terminates here, together with extensive brick-yards on the South River, did a large commerce on the stream, estimated in 1871 at 3,053,857 tons per annum.

The present project was adopted in 1874, and provides for obtaining by diking and dredging, and, where necessary, by drilling and blasting rock, a channel 200 feet wide and 10 feet deep at mean low water from the mouth to New Brunswick, at a cost of $2,093,662.05. It was modified in 1881, pursuant to the river and harbor act of March 3 of that year, by adding to it the dredging of the South Channel, about 13,000 feet long, 100 feet wide, and 5½ feet deep at mean low water from Kearney's Dock to Crab Island.

Under this project $447,638.57 had been expended June 30, 1887, in constructing the dikes required by the project at "The Stakes" and "Middle Grounds," in dredging channels 200 feet wide and 12 feet deep at mean low water at these points, and in drilling, blasting, and dredging a channel of the same dimensions across the rocky shoals at Whitehead's Sand Dock. Under the two special allotments made for it in the acts of March 3, 1881, and August 2, 1882, the South Channel was dredged to the required depth for a distance of 4,000 feet. These improvements had been of great benefit to navigation, permitting the large tows in use on the river to reach a point 4 miles below New Brunswick at all stages of the tide. The commerce of the river was reported in 1887 at 1,675,355 tons, valued at $28,119,173.

At the close of the last fiscal year surveys of the defective portions of the river had just been completed, the results of which were reported in the last annual report. On July 27, 1887, a report was submitted to the Chief of Engineers, recommending that no work be done at Whitehead's Sand Dock with the existing appropriation, in view of the fact that the channel at that point was already in better condition than either above or below, but that $15,000 be expended in dredging a channel 100 feet wide and 10 feet deep across the three shoals between Whitehead's Sand Dock and Martin's Dock, the best depth on the crests of these shoals being 8.4, 8.0, and 6.9 feet respectively. This work would bring the improved channel to within 1⅞ miles of the city of New Brunswick. This project was approved by the Chief of Engineers August 6, 1887. Specifications were prepared and advertised twenty-five days. Sealed proposals were opened September 7, 1887. The lowest bid was that of M. K. Pidgeon, who proposed to dredge the loose material from the 700 feet of the lower shoal where the rock crops out above the contract depth, for $14 per cubic yard, and the remaining 4,100 feet of the channel across the shoals for 47 cents per cubic yard, scow measurement; the material to be dumped in the lower course of South River, which the original project for the improvement of that stream contemplates closing. These bids were considered unreasonable, and the work was readvertised.

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At the second opening of proposals, September 22, 1887, M. K. Pidgeon was again the lowest bidder (abstract of bids herewith), proposing to dredge the rocky section for $2.83, and the remainder for 43 cents per cubic yard, scow measurement. The bids were again rejected and authority obtained to hire the necessary plant and do the work by the day. While negotiations to this end were in progress, it became apparent that it would not be advisable to close the lower course of South River at present, if at all, so that the proposed dumping-ground could not be used. It was then decided to dump the material along the face of dikes A and 1, Raritan River, and use a second dredge to pick it up again and throw it over the dike.

Dredging began November 21, and was discontinued December 22 on account of the freezing of the river.

A dipper dredge, 3 scows, and tug-boat were hired at $8.40 per hour; and a clam-shell dredge, 3 scows, and tug-boat at $78 per day. The first was put to work on the rocky section, and the latter mainly on the remainder of the shoal, though partly on the rocky section also.

The cost of digging and dumping 3,695 cubic yards was 55.6 cents per cubic yard for the dipper dredge on the rocky section, and 37.3 cents per cubic yard for 3,935 cubic yards for the clam shell, a favorable exhibit as compared with the lowest bid.

A second clam-shell dredge was hired at $50 per day, and used to lift the dredged material over the dike, and for a short time also in working on the shoal. The lifting over the dike cost 10.6 cents per cubic yard, making the total cost of dredging and disposing of the material 56.8 cents per cubic yard, scow measurement.

When work was suspended a survey of the shoal showed that 4,990 cubic yards measured in place had been removed, making a channel 10 feet deep at mean low water across the shoal, 25 feet wide at its narrowest point, though in most places 75 feet wide. The rocky section was nearly completed.

Operations this season have not yet been resumed. The only proposition received for hiring plant by the day has been $168 per day for dredge, tug-boat, and scows, which is extravagant. Three propositions were received for doing the work by the yard: Brainard Bros., at 59 cents per cubic yard; H. Du Bois' Sons, at 55 cents; and M. H. Flannery, at 50 cents. These propositions were all rejected, but the work was subsequently offered to M. H. Flannery at 40 cents per cubic yard, subject to approval of the Chief of Engineers; this offer Mr. Flannery accepted, and it has since been approved by the Chief of Engineers by indorsement of June 12 1888, on my report of June 2. The dredged material is to be used by the contractor in building an earthen dike or embankment on the left bank of the river at the Middle Grounds, it being believed that the material, which is mainly coarse gravel, is sufficiently heavy not to be removed by the currents, though, if necessary, the face of the dike can be protected with stone at small expense. The construction of this dike was recommended in my report of June 2, and was approved by the Chief of Engineers June 11.

The channel dredged at the Middle Grounds in 1884, to a depth of 12 feet and width of 130, has not maintained itself well, but has shoaled opposite the site of the proposed dike, till there is barely a continuous 10-foot channel not over 50 feet wide. The shoaling is believed to be due to the fact that the width of the river is excessive at this point. The dike is to be about 3,260 feet long, and is to be built to the level of high water, contracting the river to the width of 600 feet, which is its width just above and below. This dike will also serve the purpose of

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making available a small dumping-ground between it and shore, which is badly needed.

Work is to be begun on the dike and the dredging under agreement with M. H. Flannery July 1.

The price at which the work is to be done, 40 cents per cubic yard, scow measurement, is considered reasonable in view of the fact that nearly all of the material will have to be handled twice; but this price was only obtained by bargaining, and it is now a well-known fact that owners of dredging plant in the vicinity of New York have so combined that there is no longer any competition for Government work, so that prices have been raised beyond a reasonable limit. A great saving to the Government would result from its owning at least one complete dredging plant in this neighborhood, as the working of that plant would set a standard that the prices bid on other works could be compared with.

Much office work has been done during the year at considerable expense, in posting up the maps and records of the improvement since its beginning.

The drill-scow and launch *Raritan*, which were in an entirely unserviceable condition at the beginning of the year, have been put in good repair, one-half of the expense being borne by the improvement of New Rochelle Harbor, in charge of Lieutenant-Colonel Houston, Corps of Engineers, who has since used the plant on that improvement during the fall and spring. An opportunity offering to exchange the launch *Raritan* with the commanding officer at Willets Point, for the tug-boat *Star*, which is much more suitable for the work on the Raritan River, the exchange was made with the approval of the Chief of Engineers, and she has been put in good running order.

The expenditures during the fiscal year ending June 30, 1888, amount to $9,036.01, as follows:

Dredging and dumping 7,630 cubic yards	$4,331.13
Inspection	429.74
Advertising	49.70
Survey of shoals below Martin's Dock	306.42
Examination after dredging	38.30
Draughting (old records and new work)	364.35
Care and storage of rock-drilling plant	175.00
Repairs of launch and drill-scow	1,733.78
Fitting out tug-boat *Star*	499.32
Administration	1,108.27
Total	9,036.01

The commerce of the Raritan River is very large; the city of New Brunswick has a population of about 20,000 people, and is the terminus of the Delaware and Raritan Canal.

The amount that can be expended profitably, as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, is $100,000, and if appropriated, will be expended in carrying the improved channel further up the river toward New Brunswick.

The estimated amount required for the completion of the improvement is $1,622,412.05.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry; nearest light-house, Great Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at Perth Amboy, during the fiscal year ending June 30, 1888, $57,727,64.

Original estimate	$2,093,662.05
Amount appropriated	471,250.00
Amount received from sales of fuel (A. R. C. E., 1882–'83)	180.00
Amount received from sale of fuel to Captain Derby	2.00
Amount expended (including outstanding liabilities)	456,860.14

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Money statement.

July 1, 1887, amount available		$23,651.91
Amount received from Captain Derby for sale of fuel (March 31 and June 29, 1888)		2.00
		23,653.91
July 1, 1883, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$8,896.49	
July 1, 1888, outstanding liabilities	185.56	
		9,082.05
July 1, 1888, balance available		14,571.86
Amount appropriated by act of August 11, 1888		50,000.00
Amount available for fiscal year ending June 30, 1889		64,571.86
Amount (estimated) required for completion of existing project		1,572,412.05
Amount that can be profitably expended in the fiscal ending June 30, 1890		100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for dredging in Raritan River, New Jersey, opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock, m., on September 7, 1887, under advertisement dated August 13, 1887.

No.	Name and residence of bidder.	Name and residence of sureties.	Bid per cubic yard, in scow.	
			700 feet rocky section of channel.	Remaining 4,100 feet of channel.
*1	M. K. Pidgeon, 60 South street, New York City.	John P. Hawkins, C. C. Ellis, New York, N. Y.	$14.00	$0.47
2	Hartford Dredging Company, Hartford, Conn.	Charles J. Hills, Edward G. Lasbury, Hartford, Conn.	25.00	.60
†3	Elijah Brainard, 24 State street, New York.	Theodore Smith, Henry Smith, Jersey City, N. J.	15.20	.49

* Commence according to specifications and finish according to same.
† Commence on or before October 1, 1887.

Abstract of bids for dredging in Raritan River, New Jersey, opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock, m., on September 22, 1887, under circular dated September 12, 1887.

No.	Name and residence of bidder.	Name and residence of sureties.	Price per cubic yard, measured in scow.	
			700 feet rocky section of channel.	Remaining 4,109 feet of channel.
1	W. H. Beard, 302 Hamilton avenue, Brooklyn, N. Y.	C. N. Kingsland, M. D. Lawrence, Brooklyn, N. Y.	*$3.50	$0.48
2	Elijah Brainard, 24 State street, New York City, N. Y.	Joseph Laughlin, New York, N. Y.; George W. Rogers, Elizabeth, N. J.	†3.60	.46½
3	Hartford Dredging Company, Hartford, Conn.	Charles J. Hills, Edward G. Lasbury, Hartford, Conn.	18.00	.55
4	M. K. Pidgeon, 60 South street, New York City, N. Y.	John P. Hawkins, A. J. Atwater, New York, N. Y.	2.83	.43

* For all material that can be dredged without blasting.
† Rock-work not included.

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COMMERCIAL STATISTICS.

The following statistics relative to commerce of the Raritan River during the calendar year 1887, were compiled in this office by Mr. C. S. Kelsey, surveyor:

Population of Middlesex County in 1885	56,180
Assessed valuation of real estate in 1880, Middlesex County	$15,974,111
Assessed valuation of personal property in 1880, Middlesex County	3,898,358
Total value of productions of farms in 1879, Middlesex County	1,486,147
Total value of materials of manufacture in 1879, Middlesex County	5,391,913
Total value of products of manufacture in 1879, Middlesex County	9,587,832

EXPORTS.

Articles.	From South River.		From Delaware and Raritan Canal.		Below New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Products of forests	5,500	$23,700	117,116	$136,928	100	$1,000	122,716	$161,628
Products of mines:								
Coal	.....	.....	472,690	2,033,044	.....	.....	472,690	2,033,044
Clay, ores, etc	6,354	16,801	28,445	850,070	90,309	149,658	125,108	1,016,529
Agricultural products	.....	.....	12,480	936,000	.....	.....	12,480	936,000
Products of manufacture	182,500	513,000	.....	.....	103,840	538,224	346,340	1,056,224
Miscellaneous merchandise, etc	1,000	50,000	218,438	12,192,600	7,334	325,000	226,772	12,567,600
Total	195,354	608,501	849,169	16,148,642	261,583	1,013,882	1,306,106	17,771,025

IMPORTS.

Products of forests	350	$1,125	18,546	$463,650	.....	.....	18,896	$464,775
Products of mines:								
Coal	14,515	66,652	47,380	204,207	22,800	$95,000	84,695	365,859
Clay, ores, etc	.....	.....	52,387	1,002,555	.....	.....	52,387	1,002,555
Agricultural products	.....	.....	22,660	1,699,500	.....	.....	22,660	1,699,500
Manufactured products	500	51,000	.....	.....	.....	.....	500	51,000
Merchandise and miscellaneous	18,460	145,500	165,651	6,368,959	6,000	250,000	190,111	6,764,459
Total	38,825	264,277	306,624	9,738,871	28,800	345,000	369,249	10,348,148

The commerce of South Amboy is not included in the above. During the year 36,600 tons of clay and sand, valued at $85,000, were exported by rail from the vicinity of the river.

Three brick-yards have been completed since 1887, with a combined capacity of 22,000,000 brick, having a value of $271,000.

Enumeration of craft passing through the draw-bridge at the mouth of Raritan River.

Years.	Steamboats.	Propellers.	Tugs.	Tows.	Schooners.	Sloops.	Skiffs and yachts.	Total.
Calendar year 1880	.....	.....	.....	.....	.....	.....	.....	13,405
Calendar year 1886	712	1,724	1,883	2,241	3,772	2,088	1,007	13,427
Year ending June 30, 1887	818	1,636	1,850	2,563	4,080	2,035	963	13,945

Of the above number 7,257 loaded boats passed in and out of the Delaware and Raritan Canal, at New Brunswick Lock, during the year 1887.

COMMERCIAL STATISTICS.

Commercial statistics of the port of Perth Amboy, N. J., for the fiscal year ending June 30, 1888.

Amount of revenue collected	$57,727.64
Value of all imports	204,761.00
Value of all exports	1,499,371.00

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Shipping.	Number.	Registered tonnage.
Foreign vessels entered from foreign countries	20	24,313
Foreign vessels cleared for foreign countries	91	68,678
American vessels from foreign port	5	1,553
American vessels for foreign ports	17	7,485
Coastwise vessels entered	256	119,379
Coastwise vessels cleared	72	52,337

Among "coastwise vessels entered" are included thirteen foreign vessels 18,485 tons, which came here with foreign cargo, having first discharged other foreign cargo at New York. Among "coastwise vessels cleared" are included seven foreign vessels (3,780 tons) and five American vessels (4,103 tons) which loaded at this port cargo for a foreign port, but went to New York for additional cargo.

Number and tonnage of all vessels belonging to the port of Perth Amboy, N. J., June 30, 1888.

	Number.	Registered tonnage.
Steam vessels	44	7,242.60
Sailing vessels	307	15,841.71
Barges	62	20,355.95
Canal boats and scows	2	246.40
Total	415	43,686.66

Including vessels belonging here, but temporarily documented elsewhere, June 30, 1888, not including vessels belonging at other ports yet documented here on that date.

F 6.

IMPROVEMENT OF SOUTH RIVER, NEW JERSEY.

Before the improvement of this stream was undertaken by the United States the navigation of the lower 2½ miles of its course had been abandoned, and a canal dredged at private expense from a short distance below Washington to Sayreville, on the Raritan River. In 1880, when the present project for improving the river was adopted, the mouth of this canal, on account of its faulty location, had shoaled to a depth of 4.6 feet at mean low water, and the best depth in the canal, some distance above, had decreased to 3.3 feet. Above Washington a depth of 2.7 feet existed to Bissett's, 3⅝ miles, and of 2.5 feet to Old Bridge, the head of navigation, 6¼ miles above the mouth of the canal at Sayreville. The range of the tide was 5.3 feet at Sayreville. The town of Washington and numerous brick-yards did a commerce on the river valued at $1,249,000.

The present project, adopted in 1880, provides for closing the river below the head of the canal, correcting the direction of the mouth of the latter, and obtaining, by diking and dredging, a depth of 8 feet mean low water to Washington, 6 feet to Bissett's, and 4 feet to Old Bridge, straightening the channel at two points by cutting across the meadow. It was estimated to cost $194,695.

The amount expended under this project to June 30, 1887, $55,863.31, with which the direction of the mouth of the canal had been changed, the dikes below Washington completed, and a small amount of dredging done on a shoal above Washington. No increase in the commerce of the river had been observed.

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At the close of the fiscal year $5,111.75 was available for this improvement; a survey of the river and canal from Washington to Sayreville was completed in June, 1887, and reported on in the last annual report. It was determined to expend the available funds in dredging a channel 8 feet deep through the canal and river, from the mouth of the canal to the town of Washington. Specifications were prepared and the work advertised August 12, 1887, at the same time as the dredging on the Raritan River. Bids were opened September 7, 1887 (abstract herewith). The lowest bidder was the Hartford Dredging Company, at 30 cents per cubic yard, scow measurement, which was considered unreasonable. The bids were rejected, and the work readvertised. At the second opening the Hartford Dredging Company was again the lowest bidder, at 29 cents (abstract of bids herewith). The bids were again rejected, and authority obtained to hire the necessary plant and do the work by the day.

A dipper dredge was hired with three small scows and tug-boat at $8.40 per hour. Work was begun October 17, 1887, cutting away the shoal on the right bank at the mouth of the canal, and dumping the material in the lower course of South River below Pettit's brick-yard, the existing project approved in 1880 providing for entirely closing this channel. The fact was shortly developed, however, that residents on the banks of this portion of the stream strongly objected to the channel being closed or obstructed, notwithstanding the fact that a better water-way exists from their property to the Raritan River *via* the canal than *via* the lower course of the river, and that no vessel ever uses the latter channel except on the rarest occasions. A petition was submitted signed by forty residents and boat owners of the neighborhood requesting that no obstruction be placed in this portion of the river, alleging that said channel is of value to commerce and navigation, and will be of value even when a depth of 8 feet at mean low water has been obtained through the canal.

In my judgment, closing the lower course of the river is not an essential feature of the existing project, as I feel no uncertainty about the volume of water that flows naturally through the canal being quite ample to maintain a depth of 8 feet at mean low water. It was therefore thought advisable to defer to the wishes of the residents of the neighborhood and find some other means of disposing of the material dredged from the canal, even though this involved the additional expense of handling all the dredged material twice in placing it behind the dikes in the canal.

In addition to the dipper dredge already at work, two clam-shell dredges with two 300-yard scows were hired at $100 per day, and were employed excavating a channel across the shoal between Dikes D and E in the canal, and across the shoal in the river abreast of Dike F, just below Washington. The dredged material was placed behind the dikes adjacent to the cuts made, with the exception of 441 cubic yards dumped in the lower course of South River. Work was continued until December 8, when the available funds were exhausted. A survey was then made and the work measured in place, showing the following results:

	Measured in scows.	Measured in place.
Dredged from shoal at the mouth ..... cubic yards..	4,518	3,163
Dredged from channel between Dikes D and E ..... do....	10,802	8,390
Dredged from shoal at Dike F ..... do...	1,495	776
Total.....	16,815	12,329

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The entire quantity dredged from between Dikes D and E, as measured in place, is 11,074 cubic yards, indicating that in putting the dredged material behind the dikes the dredge removed somewhat more than had been dumped.

Total number of cubic yards dredged this season	16,815
Cost of dredging and dumping, per cubic yard	$0.165
Cost of lifting dredged material over dike, per cubic yard	.079
Total cost, per cubic yard	.244

The lowest bid received for the above work by contract was 29 cents, which did not include lifting the dredged material over the dike.

Vessels drawing 6 feet can reach Washington at mean low water; the 6-foot channel is 50 feet wide at Dike F, and 60 feet in the canal, where it is likely to be improved by the currents.

Messrs. Sayre and Fisher, the owners of the brick-yards at the mouth of the canal, have made the claim that it was one of the conditions on which they deeded certain lands to the United States in 1881 for the use of the improvement of South River that the United States should build Dike A continuously from the meadow bank, where it now starts, to the corner of their dock at the mouth of the canal; and they accordingly made application during the year to have the dike extended downstream to the corner of their dock, a distance of about 230 feet, they being anxious to use the dike as a dock front. A map showing the locality will be found, page 764 of the Annual Report of the Chief of Engineers for 1885. The records of this office indicate that the construction of this dike was not a part of the consideration for which the land was deeded, and it does not form part of the existing project; the application of Messrs. Sayre and Fisher was therefore not granted. It was, however, finally settled, that in consideration of all claim against the United States being abandoned by Messrs. Sayre and Fisher, and their proceeding to close the gap between their dock and the end of the dike by the construction of a suitable bulkhead, that the shoal along this front on the right bank of the mouth of the canal, which had reformed since it was dredged by the United States in 1882, would be dredged again by the United States to a depth of 6 feet mean low water; and these arrangements have been carried out, greatly improving the entrance to the canal.

The steamer running to Washington having been seriously damaged by running onto Dike B during an extraordinarily high tide, fender-piles were driven along the dike at small expense, to prevent the recurrence of such an accident.

The expenditures for the last fiscal year amount to $4,875.09, as follows:

Dredging 16,815 cubic yards	$4,106.94
Inspection of above	484.44
Examination after dredging	20.63
Placing fender-piles along face of Dike B	32.50
Draughting (old records and new ones)	101.40
Administration	129.18
Total	4,875.09

The commerce of the stream is steadily increasing. The largest brick-yards in the world are situated on its banks, and the number of brick made during the past year is greater than ever before. The majority of the vessels engaged in this trade can only reach their destination by waiting for the tide. A larger steam-boat making daily trips to New York has been put on this year.

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The sum of $30,000 can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890. It would be applied to giving the channel the full dimensions required by the project below Washington, and in extending the improvement to the brick-yards above; this would add greatly to the shipping facilities of the stream and would stimulate its increasing commerce.

The estimated amount required for the completion of the improvement is $133,695.

This work is in the collection district of Amboy. The nearest port of entry, Perth Amboy, N. J.; nearest light-house, Great Beds Light, in Raritan Bay, N. J.; nearest fort, at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate	$194,695.00
Amount appropriated	61,000.00
Amount received from sales of coal (A. R. C. E. 1883)	30.06
Amount expended	60,738.40

Money statement.

July 1, 1887, amount available	$5,111.75
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,820.09
July 1, 1888, balance available	291.66
Amount appropriated by act of August 11, 1888	5,000.00
Amount available for fiscal year ending June 30, 1889	5,291.66
Amount (estimated) required for completion of existing project	128,695.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids for dredging in South River, New Jersey, opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock, m., on September 7, 1887, under circular letter dated August 12, 1887.

No.	Name and residence of bidder.	Name and residence of sureties.	Price per cubic yard measured in scows.
			Cents.
*1	M. K. Pidgeon, 60 South street, New York City.	John P. Hawkins, C. C. Ellis, New York City.	40
2	James McSpirit, 330 Third street, Jersey City, N. J.	Thomas Potter, Joseph M. Potter, Jersey City, N. J.	35
3	Hartford Dredging Company, Hartford, Conn.	Charles J. Hills, Edward G. Lasbury, Hartford, Conn.	30

* Will commence within ten days from notification of award.

Abstract of bids for dredging in South River, New Jersey, opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock, m., on September 22, 1887, under circular dated September 12, 1887.

1	P. Sanford Ross, 113 Hudson street, Jersey City, N. J.	Freeman A. Smith, Theodore Smith, Jersey City, N. J.	29½
2	M. K. Pidgeon, 60 South street, New York City, N. Y.	John P. Hawkins, A. J. Atwater, New York City.	32
3	W. H. Beard, 302 Hamilton avenue, Brooklyn, N. Y.	C. N. Kingsland, M. D. Lawrence, Brooklyn, N. Y.	35
4	James McSpirit, 330 Third street, Jersey City, N. J.	Joseph M. Potter, Rahway, N. J.; Thomas Potter, Jersey City, N. J.	34
5	Hartford Dredging Company, Hartford, Conn.	Charles J. Hills, Edward G. Lasbury, Hartford, Conn.	29
6	Richard M. Payn, 63 Quay street, Albany, N. Y.	Edgar M. Payn, Dominick Fitzpatrick, Albany, N. Y.	29½

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COMMERCIAL STATISTICS.

The following statistics relative to the commerce of South River, New Jersey, during the calendar year 1887, were compiled in this office by Mr. C. S. Kelsey, surveyor.

The population of East Brunswick in 1885 was	3,697
Assessed valuation of real estate in 1880, East Brunswick township	$789,170
Assessed valuation of personal property in 1880, East Brunswick township	241,400
Total (estimated) value of farm products	124,000

Articles.	Tons.	Value.
Exports.		
Common brick	181,700	$418,000
Clay and sand	6,354	16,801
Cord wood, posts, poles, piles, etc	5,500	23,700
Manufactures	1,000	100,000
Farm products and general merchandise	1,000	50,000
Total	193,354	608,501
Imports.		
Coal	14,515	66,652
Building material	460	10,500
Wood	350	1,125
Fertilizers	17,000	35,000
Manufactures and general merchandise	1,500	151,000
Total	33,825	264,277
Total commerce	229,179	872,778

Two new brick-yards have been recently established with a capacity of 15,000,000 per year, valued at $75,000. The entire product of the brick-yards is exported by water, and has steadily increased in amount since 1880, having more than doubled since that date.

F 7.

IMPROVEMANT OF CHEESEQUAKES CREEK, NEW JERSEY.

In its original condition the stream was obstructed at its mouth by a sand-bar, on which the best depth was 1 foot at mean low water; for about a mile of its length the channel had a depth of 6 feet, but the remainder had generally a depth of 3 feet and less. The range of the tide is 5.1 feet. Five hundred and forty-six small vessels passed the draw at the mouth of the creek in 1878.

The project for the improvement was adopted in 1879, and provides for obtaining by dredging and diking a channel 5 feet deep at mean low water, and 200 feet wide at the mouth of the creek, and 4 feet deep with a width of from 100 to 50 feet to the head of navigation at Whitehead's Dock, 3 miles from the mouth. The amount expended under this project to June 30, 1887, was $40,000: the least depth in the improved channel at the mouth was 4.5 feet at mean low water; no work had been done on the shoals above; and no increase in the commerce of the creek had been observed.

There have been no funds available during the year ending June 30, 1888, and no expenditures. The condition of the creek and its traffic remains substantially unchanged. The works at the mouth of the creek were examined by the engineer in charge, June 26. The beach has been cut away to a considerable extent at the inner ends of the jetties, and

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for a distance of 50 feet on the west jetty and 100 feet on the east jetty; the waves, breaking on the beach at high tide, flow over the inner ends of the jetties, carrying large quantities of sand into the dredged channel between them. Just above the bridge abutment, for a distance of 50 feet, the sheet-pile revetment, in prolongation of the sheet-pile dam across the old channel, has given way and will shortly fall entirely.

The maintenance of the works themselves and the channel between the jetties requires that repairs should be made forthwith, both on the revetment and on the jetties, raising their inner ends to the height of the rest of the structure. These repairs would cost about $1,000.

If it is the intention of Congress to complete this improvement, the sum of $25,000 can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and it would be expended in dredging; a slight increase in the commerce of creek might be expected.

The estimated amount required for the completion of the improvement is $50,000.

This work is in the collection district of Perth Amboy, N. J. Nearest light-house, Great-Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy, during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate (revised, 1885)	$90,000
Amount appropriated	40,000
Amount expended	40,000

Money statement.

Amount (estimated) required for completion of existing project	$50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

F 8.

IMPROVEMENT OF KEYPORT HARBOR, NEW JERSEY.

Keyport Harbor was originally accessible at low water only to vessels drawing less than 4 feet. Before its improvement was undertaken by the United States a 6-foot channel had been dredged at private expense, which had shoaled in 1872 to 5½ feet, and in 1882 to 5 feet, the range of the tide being 4.7 feet. A large commerce was carried on, however, valued at $2,932,000.

The project for the improvement was adopted in 1873, and provided for dredging a channel 4,700 feet long, 8 feet deep at mean low-water, and 200 feet wide from the steam-boat dock to the 8-foot contour in Raritan Bay, at an estimated cost of $30,475.

The amount expended under this project to June 30, 1887, was $30,020.51, with which a channel had been dredged from the 8 foot depth in Raritan Bay to Keyport Wharf, a distance of 5,000 feet, with a width of 200 feet for the first 4,200 feet and 160 feet for the remainder.

The commerce of the harbor had increased greatly, being estimated at $5,000,000, besides 150,000 passengers carried annually.

There has been no appropriation for this work since 1882, and the expenditures for the last fiscal year have amounted to $22.38 for office expenses.

The dredged channel is stated to have shoaled in places to about 6

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feet mean low water, but it is reported that the commerce as yet shows no falling off.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $10,000, can be expended profitably as regards the efficient prosecution of the work during the fiscal year ending June 30, 1890, and would be applied to dredging the channel to the dimensions required by the project, which would add materially to existing facilities.

The estimated amount required for the completion of the improvement is $10,000.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house, Great Beds Light, in Raritan Bay; nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy, during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate (1873)	$30,475.00
Revised estimate (1884)	40,475.00
Amount appropriated	30,475.00
Amount expended, including outstanding liabilities July 1, 1888	30,047.89

Money statement.

July 1, 1887, amount available		$454.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$22.38	
July 1, 1888, outstanding liabilities	5.00	
		27.38
July 1, 1888, balance available		427.11

Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

F 9.

IMPROVEMENT OF MATTAWAN CREEK, NEW JERSEY.

Before its improvement by the Government this small stream was obstructed at its entrance to Keyport Harbor by a mud flat, on which the best depth at the worst section was 3.1 feet at mean low water, though the 3-foot channel was too narrow and tortuous for use. Above this flat a good 4-foot channel existed to 1⅛ miles above the mouth, and thence to the steam-boat dock at Mattawan 3.5 feet, shoaling to 1.8 feet at the freight dock, 600 feet above, and 1⅞ miles from the mouth. The range of the tide is 4.7 feet. Notwithstanding the above difficulties it carried commerce valued in 1880 at $800,000.

The project for the improvement was adopted in 1881, and provides for dredging a channel 4 feet deep at mean low water, and 100 feet wide from the mouth to Winkson Creek, and thence 75 feet wide to the railroad bridge at Mattawan, 250 feet above the freight dock, at an estimated cost of $33,120.

To June 30, 1887, the amount expended under this project was $21,000, with which a channel had been dredged, giving the required depth, from the mouth to the freight dock at Mattawan, with widths varying from 100 to 30 feet.

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The estimated value of the commerce of the creek had increased to over $2,000,000, in 1885, amounting to 130,000 tons.

There has been no appropriation for this stream since 1882; there were no funds available for the past fiscal year, and there have been no expenditures. The condition of the stream has deteriorated since work was suspended, and complaints are made of shoaling at the mouth of the river. There has been no increase in the amount of commerce reported above, which is already very large in proportion to the facilities offered by the stream.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $12,120, can be expended profitably, as regards the efficient prosecution of the work, during the fiscal year ending June 30, 1890, and would be applied to dredging the channel to the dimensions required by the project, which would add materially to existing facilities.

The estimated amount required for the completion of the improvement is $12,120.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house Great Beds Light, in Raritan Bay. Nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate	$33,120.00
Amount appropriated	21,000.00
Amount expended	21,000.00

Money statement.

Amount (estimated) required for completion of existing project	$12,120.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	12,120.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statistics, relative to commerce of Mattawan Creek, N. J., during the calendar year 1887, were compiled in this office by Mr. C. S. Kelsey, surveyor, mainly from statements furnished by Mr. J. H. Hornor, of Mattawan:

Articles.	Value.
Exports.	
Common brick	$96,000
Farm produce and garden truck (estimated from Census Report)	100,000
Total	196,000
Imports.	
Lumber and building material	28,500
Flour, feed, and grain	26,000
Fertilizers	55,000
Coal	10,000
Hardware	15,500
Groceries and general merchandise	46,000
Total	181,000
Total commerce	377,000

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F 10.

IMPROVEMENT OF SHREWSBURY RIVER, NEW JERSEY.

The project for this improvement was adopted in 1879, and contemplates the formation of a channel 6 feet deep at mean low water, and from 300 to 150 feet in width, from the mouth of the river to Red Bank, on the North Branch, 8 miles, and to Branchport, on the South Branch, 9 miles.

In its original condition the river was much obstructed by sand-bars on which the best depths at mean low water were, at the mouth, 3.9 feet; below Highland's Bridge, 5.4 feet; at Lower Rocky Point, 3.6 feet; at Barley Point, 3.3 feet; at Chalmers, 5 feet; at Oceanic, 5.5 feet; below Bellevue, 3.1 feet; at Seabright Bridge, 4.2 feet; at Jumping Point, 2.6 feet; at Sedge Island, 2.8 feet. A survey completed in April, 1887, shows the depths at these points to be 5.9 feet, 5.9 feet, 7.7 feet, 3.6 feet, 7.8 feet, 7.2 feet, 4.5 feet, 7.2 feet, 5.9 feet, 4.4 feet, respectively. No changes are known to have taken place since.

The estimated cost of the existing project is $254,562, of which $200,128.58 had been expended June 30, 1888.

A project recommending the construction of stone dikes C_3, C_4, and M was approved by the Chief of Engineers July 13, 1887, and sealed proposals were invited by circular letter, and opened August 10, 1887 (abstract of bids herewith). A map showing the proposed work will be found in the Annual Report of the Chief of Engineers for 1887, page 780. A contract was made August 20, with F. P. Eatman, the lowest bidder, to construct the dikes at 98 cents per cubic yard of stone; measured on scows and delivered in the dikes; the work was to be completed by November 1, 1887. The facilities of the contractor for doing the work proved to be inadequate; the contract was extended to December 1, and again to May 15, 1888, when the contractor reported his inability to complete the work, having delivered 1,843 cubic yards of stone which had been placed in dikes C_3 and C_4.

This delay caused considerable loss to the United States, increasing the cost of inspection while work was in progress, and causing the loss of the bunches of piles driven to mark the line of the dikes, nearly all of which were carried away by the ice during the winter.

On May 17 the work was again advertised, and sealed proposals were opened May 26 (abstract herewith). The lowest bidder was A. J. Howell, with whom a contract was make June 7, to deliver 2,000 cubic yards of stone at $1.45 per cubic yard. The contractor began the delivery of the stone June 2, and has carried on the work steadily until the close of the fiscal year, when all the stone, 2,011 cubic yards, had been received on the work, and all had been placed in the dikes with the exception of one load of 333 cubic yards.

Dike C_4, 1,260 feet long, has been built to the height of extreme low water, and 4 feet wide on top, except for a distance of 30 feet at its junction with C, where it was only raised to 2 feet below mean low water to permit the passage of row-boats. Dike C_3 has been built to the height of 1 foot above mean low water, and from 4 to 6 feet wide on top. This completes the dike for the present, though it will require more stone later, when the current in the river has scoured along its face and caused the stone to settle.

It may also be necessary to protect the top of the dike and its outer face above low water with large blocks of stone, if it is found that ice

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injures the present structure. This dike is 1,304 feet long, and has cost $2,685.02, as follows:

1,104 cubic yards of stone, at 98 cents	$1,081.92
891 cubic yards of stone, at $1.45	1,291.95
Piles marking line of dike	145.82
Inspection	165.33
Total	2,685.02

This makes the cost of the dike $2.06 per linear foot, or $1.93, deducting the cost of inspection for comparison with the pile-dikes C_1 and C_2, which cost $4.75 per linear foot. It is believed that the cost of maintenance will in the long run also be much less for the stone-dikes than for the pile-dikes. Nearly all of the latter on the river are now in need of repair; the crib at the end of C_1 has been injured by the ice, and dikes B and C_2 require refilling with stone, the current having scoured away the bottom outside of them, allowing the sand under the stone to run out, so that the latter has settled several feet.

A complete series of tidal observations was made during the year, 8 stations being occupied with self-registering gauges. The records are nearly all reduced, and most of the stations have been connected with lines of levels.

The expenditures during the fiscal year amount to $3,195.08, as follows:

Driving guide-piles	$401.00
Constructing stone-dikes (contract of August 20, 1887)	1,625.52
Inspection of above	223.67
Draughting (old records and new work)	103.75
Tidal observations	451.64
Administration	389.50
Total	3,195.08

Whatever appropriation may be made by the next Congress will be expended in completing the dikes and dredging the shoals. The most economical results in the prosecution of the work can be obtained if the full amount required to complete the project be appropriated at once.

The Shrewsbury River is susceptible of being made a valuable navigable river at moderate expense. Its commerce is very considerable, its shores are thickly settled throughout its length, the country is very rich, and during the season of navigation the population served is very large. Six steam-boats make regular daily trips to and from New York, carrying large quantities of freight of all descriptions, and doing a large passenger traffic. Every improvement made by the Government has been promptly put to use, and on two occasions, when no appropriations were made for the river by the General Government, improvements have been made in the stream by private citizens at considerable expense.

In addition to the steamers mentioned a large number of small sailing vessels are engaged in the shipment of coal, lumber, sand, fish, and oysters. The tender of the draw-bridge at Highlands states that he is obliged to open the draw for the passage of vessels upwards of one hundred and twenty-five times daily, during the season.

This river is in the collection district of Perth Amboy, which is the nearest port of entry; nearest light-house, Navesink Light, and the nearest fort is the fort at Sandy Hook.

Amount of revenue collected during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate (revised 1887)	$254,562.00
Amount appropriated	204,500.00
Amount expended (including outstanding liabilities and amount covered by existing contracts, July 1, 1888)	203,145.88

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Money statement.

July 1, 1887 amount available		$7,456.50
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$3,085.08	
July 1, 1888, outstanding liabilities	101,35	
July 1, 1888, amount covered by existing contracts	2,915.95	
		6,102.38
July 1, 1888, balance available		1,354.12
Amount appropriated by act of August 11, 1888		10,000.00
Amount available for fiscal year ending June 30, 1889		11,354.12
Amount (estimated) required for completion of existing project		40,062.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		40,062.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for constructing stone-dikes in the Shrewsbury River, N. J., opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock m. on August 10, 1887, under circular-letter of July 26, 1887.

No.	Name and address of bidder.	Price per cubic yard of stone delivered in place.
1	F. P. Eastman, foot of East 39th street, New York City	$0.98
2	John A. Bouker, 110 Wall street. New York City	1.35

A contract was made August 20, 1887, with F. P. Eastman, the lowest bidder, for furnishing 5,000 cubic yards, more or less, of stone, and constructing about 3,700 feet of stone-dike.

Abstract of proposals for constructing stone-dikes in the Shrewsbury River, N. J., opened at the U. S. Engineer Office, Army Building, New York City, N. Y., at 12 o'clock noon, on May 26, 1888, under circular of May 17, 1888.

No.	Name and address of bidder.	Price per cubic yard of stone delivered in place.
1	John A. Bouker, 110 Wall street, New York City	$1.50
2	Alex. J. Howell, 336 West Nineteenth street, New York City	1.45

A contract was made June 7, 1888, with Alex. J. Howell, the lowest bidder, for furnishing 2,000 cubic yards, more or less, of stone, and constructing about 2,500 feet of stone-dike.

F 11.

IMPROVEMENT OF MANASQUAN RIVER, NEW JERSEY.

In its original condition this stream had a depth of from 6 to 4 feet at mean low water for several miles above its mouth, and was obstructed at its outlet into the ocean by a sand-spit, which had deflected the stream into a channel parallel with the beach, communicating with the ocean across shifting sand-bars, on which the best depth did not exceed 1½ feet at mean low water; mean range of tide 2.4 feet. In severe

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storms this channel was sometimes entirely closed by the sand, remaining so until the fresh water in the river had accumulated sufficiently to force a new outlet. Under these conditions the river could not be used by commerce.

The project for its improvement was adopted in 1879, and contemplated dredging the lower river, and obtaining by means of jetties a permanent outlet nearly at right angles to the beach, with a depth of 6 feet at mean low water, at an estimated cost of $52,120.

The amount expended under this project to June 30, 1887, was $39,000. with which two jetties had been constructed, but neither to its full length, appropriations having ceased in 1882. No permanent improvement had been effected.

There were no expenditures on account of this work during the year ending June 30, 1888, there being no funds available.

Manasquan Inlet was examined in August, 1887. High-water mark north of the inlet had not changed in position, remaining a few feet inside of the outer end of the jetty, but south of the inlet the beach had made out several hundred feet, and a sand-spit, similar to the one that existed in 1879, masked the channel between the jetties, much as that of 1879 then masked the gorge of the natural inlet. A heavy storm had lately occurred, like those which formerly closed the inlet periodically at long intervals, producing the same result as formerly. When the waters of the river broke through the beach again they scoured a channel behind the south jetty, leaving it without connection with the shore; a result which had been imminent for some years. The inner end of this jetty was in the deepest water of the inlet, and it had begun to go to pieces. If it were intended to carry out the original project, or any other project for improving the mouth of the Manasquan, it would be advisable to spend at once about $2,000 to put this dike in such condition as to prevent its entire destruction; but as there is no commerce on the river now, and no population or interests sufficient to support a trade at all commensurate with the cost of making the river available, it does not seem likely that it is the intention of Congress to complete this work, particularly as no appropriation has been made for it in several years. As the south jetty serves no useful purpose in its present condition, there would seem to be no reason for going to any expense to delay its destruction.

If it is the intention of Congress to complete this improvement, the balance of the estimate, $33,000, could be expended profitably, as regards the efficient prosecution of the work, during the fiscal year ending June 30, 1890.

The estimated amount required for the completion of the improvement is $33,000.

This work is in the collection district of Perth Amboy, N. J., which is the nearest port of entry. Nearest light-house, Great Beds Light in Raritan Bay. Nearest fort, fort at Sandy Hook, N. J.

Amount of revenue collected at the port of Perth Amboy during the fiscal year ending June 30, 1888, $57,727.64.

Original estimate (1879)	$52,120.00
Revised estimate (1882)	72,000.00
Amount appropriated	39,000.00
Amount expended	39,000.00

Money statement.

Amount (estimated) required for completion of existing project	$33,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	33,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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APPENDIX G.

IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS, AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Delaware River, Pennsylvania and Jersey.
2. Frankford Creek, Pennsylvania.
3. Schuylkill River, Pennsylvania.
4. Ice-harbor at Marcus Hook, Pennsylvania.
5. Ice-harbor at the head of Delaware Bay, Delaware.
6. Construction of iron pier, in Delaware Bay, near Lewes, Delaware.
7. Harbor at Delaware Breakwater, Delaware.
8. Rancocas River, New Jersey.
9. Woodbury Creek, New Jersey.
10. Mantua Creek, New Jersey.
11. Raccoon River, New Jersey.
12. Salem River, New Jersey.
13. Cohansey Creek, New Jersey.
14. Removal of wrecks from Delaware Bay and River.
15. Removing sunken vessels or craft obstructing or endangering navigation.
16. Survey of harbor at Atlantic City, New Jersey.
17. United States Commission advisory to the Board of Harbor Commissioners of Philadelphia, Pennsylvania.

EXAMINATIONS AND SURVEY.

18. Thoroughfare from Cape May to the Great Bay north of Atlantic City, New Jersey.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., July 6, 1888.

SIR: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1888, of the river and harbor works under my charge.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

G 1.

IMPROVEMENT OF DELAWARE RIVER, PENNSYLVANIA AND NEW JERSEY.

The river and harbor act approved August 5, 1886, contained an appropriation of $210,000 for improving Delaware River, Pennsylvania and New Jersey, of which $30,000 was to be applied to improving the channel between Camden, N. J., and Philadelphia, Pa., and $7,500, or

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so much thereof as may be needed, was to be expended on said river and its tidal tributaries above Bridesburgh.

The expenditure of this appropriation and that of July 5, 1884, has been in accordance with approved projects based upon the recommendations of the Board of Engineers of 1884 for "the permanent improvement of Delaware River and Bay."

During the past fiscal year the following operations have been in progress:

(1) Examinations at points between the upper end of Petty's Island and Delaware Bay, to determine the duration, direction, and velocity of the flood and ebb tides, and the running of a line of levels between Trenton, N. J., and Cape Henlope, Delaware.

(2) Examinations at Five Mile Bar.

(3) Construction of a brush and stone dike near Mifflin Bar, between Hog and Maiden islands.

(4) Construction of a brush and stone dike below Reedy Island.

(5) Improvement of channel across Smith's Island Bar, between Camden and Philadelphia.

1. TIDAL OBSERVATIONS AND LEVELS BELOW BRIDESBURGH.

The Board of Engineers of 1884 recommended that examinations be made at special points requiring improvement between Philadelphia and the bay to determine by means of borings and probings the character of the bottom of the river both in the channels to be improved and over the sites of proposed dikes; also that tidal observations be made to determine the duration, direction, and velocity of tidal currents; and that a line of levels be run between Cape Henlopen and Trenton.

A large part of this work had been accomplished at the close of the previous fiscal year. During the past fiscal year the field work of the tidal observations was completed, and the necessary work done to connect the lines of levels previously run. The study and discussion of the results obtained from the tidal observations and the levels are still in progress.

2. EXAMINATIONS AT FIVE MILE BAR.

A dike had been built for a distance of 3,000 feet, and to the height of mean low water, from Fisher's Point towards Petty's Island at the close of the fiscal year of 1886. The object of this dike was the improvement of the channel across Five Mile Bar, which obstructs the main channel just above Petty's Island. During the two past fiscal years, since operations ceased upon the dike, frequent examinations and local surveys have been made of Five Mile Bar to determine the extent of the dike's action toward the improvement of the bar. From these comparative examinations the following conclusions are reached: (1) The effect of the dike has been to lower the crest of the bar about 4 feet throughout a distance of about 2,000 feet. (2) The maximum effect of the dike was reached in 1886, shortly after its completion to its present extension. (3) The forces operating on the bar tending to reduce its height along the crest reached a condition of equilibrium at least a year ago, since which time no appreciable change of depth has taken place on the bar crest.

The best channel across the bar now carries, as it did last year, 6½ to 7 feet at mean low water. The distance from the head of the dike to the upper end of Petty's Island is 6,500 feet, of which distance 3,000 feet are covered by the dike, whose crest was originally at the level of

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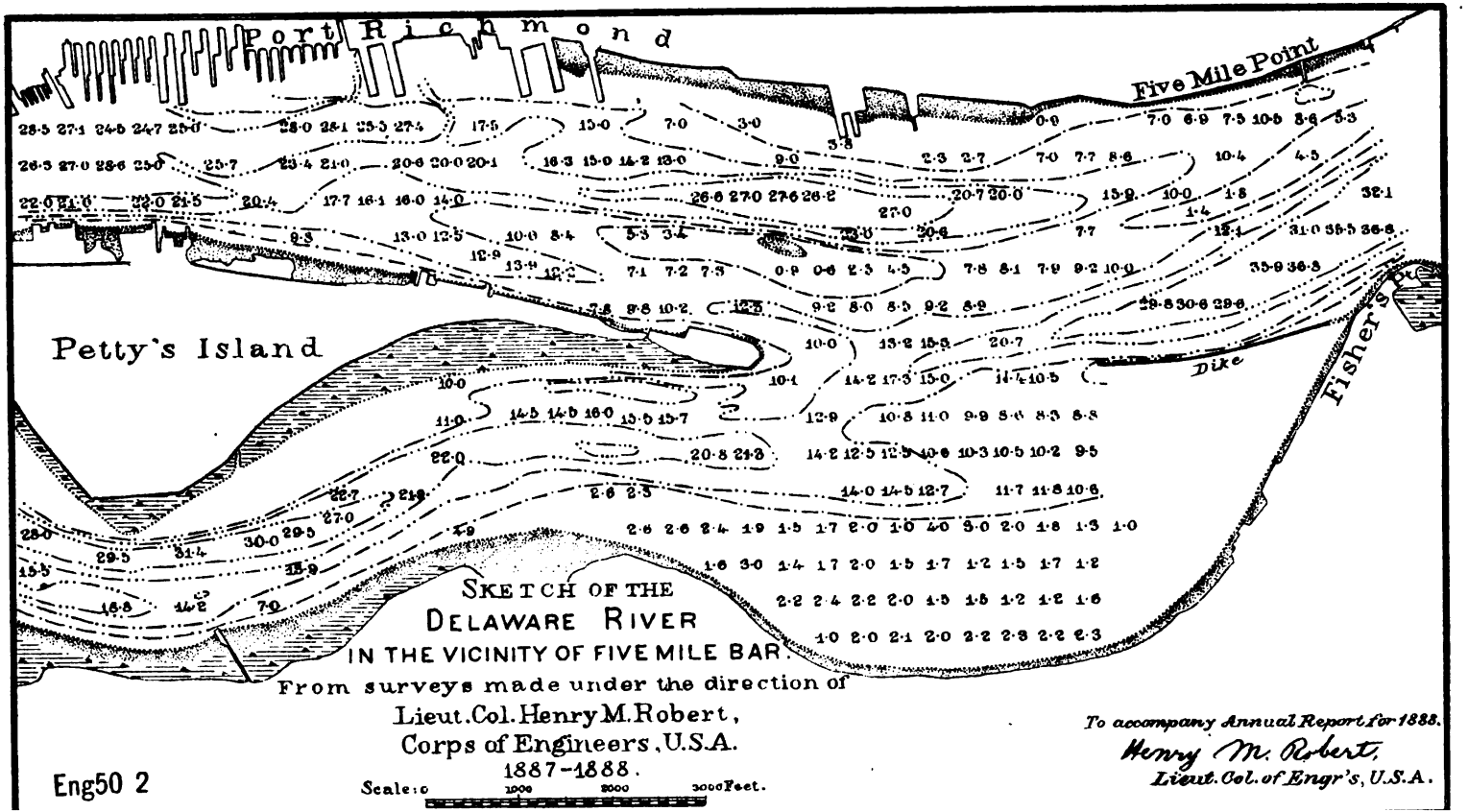

SKETCH OF THE DELAWARE RIVER IN THE VICINITY OF FIVE MILE BAR.

From surveys made under the direction of

Lieut. Col. Henry M. Robert,
Corps of Engineers, U.S.A.
1887-1888.

Scale: 0 1000 2000 3000 Feet.

To accompany Annual Report for 1888.

Henry M. Robert,
Lieut. Col. of Engr's, U.S.A.

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low water, but is now about 2 feet lower. From the action already obtained it seems highly probable that to simply extend the work as a low-water dike would result in increasing the length of depression of the bar crest without materially increasing the depth over the bar beyond about 6 feet at mean low water. The general direction of the bar is nearly parallel with the dike; therefore the action of the latter is diffused over nearly the whole length of the bar, instead of being concentrated upon a particular point.

The results already obtained do not warrant the conclusion that a sufficiently deep channel can be obtained by the dike if left at its present height, even though it be considerably extended, which will connect the deep water at Fisher's Point with the deep-water channel on the lower side of the bar. The deep water on the upper side of the bar is evidently the result of ebb tide action, while the deep water on the lower side of the bar is due to flood tide action. The axes of these channels are nearly parallel but about 1,400 feet apart, and between them lies the bar. It can not be expected that a limited extension of the dike will materially modify the character and tendency of its present action.

The diverting tendency which the dike has already exerted upon the flood tide suggests the possibility of valuable results to be obtained close to the Pennsylvania shore by a still greater diversion of the flood tide into the Pennsylvania channel past Petty's Island, and consequently across the bar. This would be obtained by the ultimate extension of the dike, both as to length and height. The passage of the resulting increased tidal volume through the Pennsylvania channel past Petty's Island would be greatly facilitated and its efficiency greatly increased by widening the river opposite the lower half of the island, as already recommended in the report of the Board of Engineers of 1888, upon the removal of the island and shoals between Philadelphia and Camden.

During the season of 1887, Prof. Lewis M. Haupt made a trial on Five Mile Bar of the value of his system of current deflectors to produce a deepened channel across the bar. The experiment was undertaken with the distinct understanding that the department had no power to grant or withhold the privilege which he had asked for as long as the river channels were not injured, and the Government was involved in no expense in connection with the experiment; that the experiment was to be made entirely at the risk and responsibility of the inventor.

The current reflectors consisted of a series of swinging wooden panels, hinged at their tops between pairs of piles placed about 20 feet apart; the tops of the panels were placed slightly above the plane of mean low water and their lower edges when hanging vertically quite near the surface of the bar. The panels were arranged on two lines with lengths respectively of 100 and 140 feet, with a clear opening between the two lines of 135 feet. In the words of Professor Haupt:

> The method embodies the principle of the utilization of the surface currents, either by a vertical deflection or by reaction, in combination with a lateral compression and concentration of a portion of the ebb and dispersion of the flood, thus producing a greater difference in the amount of the flood and ebb movements of the particles than exists in a natural or unimproved condition.

The deflectors were placed on the bar near its midlength and in water from 6 to 9 feet deep at mean low water. They remained in place from July to November, 1887, and just before their removal a detailed survey was made of the bar and a special survey of the locality occupied

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by the deflectors. This survey showed that their action had been confined to the formation of a trench from 4 to 10 feet deep along the line of the deflectors, and the deposition of the excavated material in a ridge parallel with and just below the lines of the trenches. The formation of the trenches and their parallel ridges was caused by the increased scour of the tidal currents in passing under the lower edges of the panels. The deflectors did not seem to have the effect of training the currents upon the bar between the ends of the deflectors with any valuable results, and no perceptible deepening of the bar occurred over the area which it was proposed to improve by the use of the deflectors.

In connection with the improvement of this part of the river attention should be drawn to the value of the improvement of the main ship channel west of Petty's Island, which has been in progress under late appropriations, as fully attested by the commercial development which has followed close upon the work already done. The increasing development of Port Richmond and the terminal railroad facilities thereat strongly urge the importance of a further extension of the deep water channel beyond its present upper limits.

3. DIKE BETWEEN HOG AND MAIDEN ISLANDS (MIFFLIN BAR).

The work in progress at this locality is the construction of a random stone dike about 7,200 feet in length, extending between Hog and Maiden islands. The object of this dike is the improvement of the channel over Mifflin Bar.

During the past fiscal year 23,107.42 cubic yards of stone have been placed in the dike under two contracts with Joseph H. Ward. The first contract, dated October 5, 1886, was completed September 30, 1887, by the aggregate delivery of 40,016.42 cubic yards of stone. The second contract, dated May 3, 1888, for the delivery of 12,000 cubic yards of stone, is now in progress, and has resulted in the delivery, up to the close of the fiscal year, of 6,869 cubic yards of stone.

In its present condition the dike is 7,200 feet in length, of which 5,300 feet has been brought to the surface of mean low water and 1,900 feet to a height 4 feet below that plane. With the completion of the work to be done under the existing contract the top of the dike will have been brought to the plane of low water, except for a length of 400 feet, where an opening carrying 12 feet at mean low water has been left across the dike into the basin behind it. This basin is used as a dumping ground for material dredged from the river in the vicinity of Philadelphia.

Frequent examinations have been made of Mifflin Bar and the river in the vicinity, to determine the action of the dike as already built. During the past fiscal year the dike has been raised for about 5,300 feet, or three-fourths of its length, from 4 feet below to the plane of mean low water. A comparison of the present depths of water over the bar with those of a year ago does not show any material change. The traces of the channel dredged in 1885 have not been obliterated. the distance between the 24-foot curves above and below the bar is about 1,500 feet, while the least depth between these limits and within a channel 250 feet wide is from 22½ to 23 feet at mean low water. No marked changes have taken place in the vicinity of the dike at points where undue scour had been apprehended. To produce the desired effect upon the bar, which is to maintain a 26-foot channel 600 feet wide, it seems probable that the dike will ultimately have to be raised to the plane of high water.

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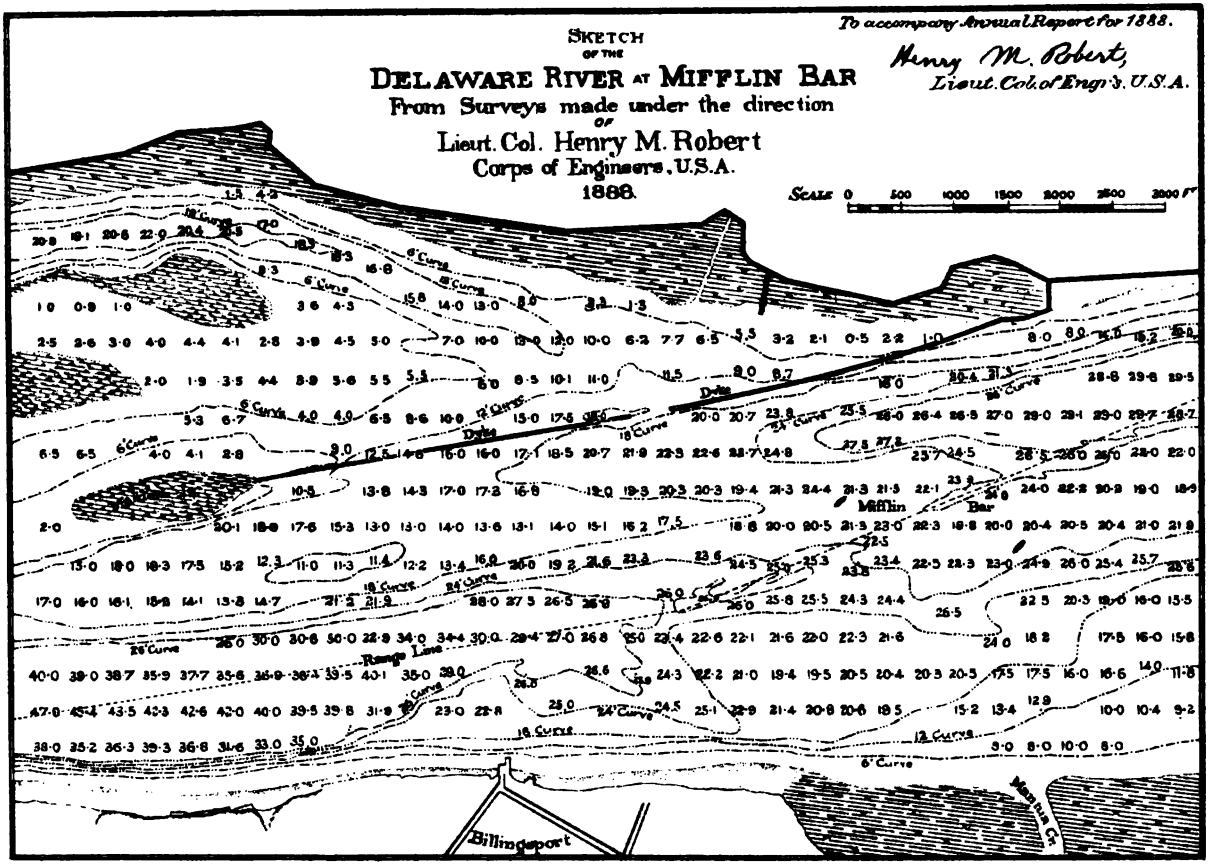

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The cost of the dike, as estimated by the Board of Engineers of 1884, was $150,000. The amount already expended in the construction of the dike, together with the amount covered by the existing contract, is about $112,000.

4. DIKE BELOW REEDY ISLAND.

The ultimate object of the work in progress at this locality is the improvement of the main ship-channel just below Reedy Island, where it is obstructed by Dan Baker Shoal, which carries a depth of only 20 feet at mean low water. The improvement in this locality, as proposed by the Board of Engineers of 1884, is to be accomplished by a dike nearly 5 miles in length, extending from the lower end of Reedy Island to a point on the right bank of the river below the mouth of Blackbird Creek.

During the past fiscal year 2,200 cubic yards of brush-mattress and 18,299 cubic yards of stone have been placed in the work, resulting in the construction to the plane of mean low water of 2,000 linear feet of dike extending southward from the lower end of Reedy Island, and the placing of the brush-mattress foundation for an additional distance of 350 feet in extension of the 2,000 feet named. This work has been accomplished under two contracts, as follows: Under a contract, dated April 16, 1887, with Milo W. Locke for the construction of the 2,000 linear feet of dike extending south from Reedy Island, 14,980 cubic yards of stone and 2,013 cubic yards of brush-mattress foundation were placed in the work, completing the contract on April 30, 1888. Under a contract, dated May 3, 1888, with the Brandywine Granite Company for the construction of about 2,000 linear feet of dike, in extension of the work done under the previous contract, 187 cubic yards of brush-mattress foundation and 3,319 cubic yards of stone have been placed during the fiscal year. The dike so far built, and that contemplated under the existing contract, consists of a brush mattress foundation about 1 foot in thickness, with a width equal to the width of the base of the dike, upon which random stone are deposited until the top of the dike is brought to the surface of mean low water.

The preliminary borings which were made along the line of the proposed dike indicated that the bottom of the river consists of quite soft clay to a depth of over 60 feet. On account of the yielding qualities of the foundation, an uncertainty existed as to the sustaining power of this soft bottom under the weights which would be imposed upon it, and an apprehension was felt that undue scour might occur along the toe of the dike. To guard against undue settlement a continuous mattress was made to cover the entire width of the base of the dike in sections 50 feet long; and to provide against scour and the consequent undermining of the foundation, the main mattress was provided with wings or curtains, hinged to it and projecting from 10 to 12 feet outside of the toe of the dike on each side. These curtain mattresses were loaded with only stone enough to cause them to sink with the main mattress and to follow with their outer edge any depression which might be produced by scour. The action of both the main and curtain mattresses was highly satisfactory in accomplishing the desired objects, and the same method will be continued during the work of this season. The limited extension of 2,000 linear feet of dike already made is too slight to yet produce any valuable effect on the shoal which it is proposed to ultimately improve through the agency of the dike.

The dike above referred to commences at the lower end of Reedy Island and extends therefrom southward. The island extends from the

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north end of the dike about 1¾ miles up the river on the line of the extension of the dike, and consequently the preservation of the island forms an essential part of the plan for the improvement of Dan Baker Shoal. An examination of the island made last fall indicated that a rapid and dangerous erosion of its shore-lines was in progress near its lower end, or just above the upper end of the dike, which threatened a breach across this part of the island. To avert such a contingency, and to hold intact the remaining narrow strip of island at this point, an inexpensive arrangement of brush was applied as a temporary shore protection at the weakened point.

To obtain the definite information necessary for a comparison between the past and present condition of the island a survey was made in December, 1887, which carefully located the existing high and low water shore-lines of the island. A comparison between this survey and those of earlier date indicates that a serious erosion has occurred along both the east and west shore-lines of the lower one-third of the island, resulting in a loss in width of about 200 feet from the former and 125 feet from the latter side of the island, and reducing the width of the fast land from over 325 feet to that of 15 feet near the lower end of the island.

The urgent necessity for preventing further erosion and giving assured permanency to the shore-lines of the lower part of the island is so apparent that a project will be submitted for the protection of this part of the island as soon as another appropriation shall render funds available therefor.

5. CHANNEL ACROSS SMITH'S ISLAND BAR.

The formation of this channel was undertaken during the previous fiscal year, in compliance with the river and harbor act of August 5, 1886, which provided that, from the appropriation of $210,000 for improving Delaware River from Trenton, N. J., to its mouth, $30,000 was to be applied "to improving the channel between Camden, N. J., and Philadelphia, Pa."

The necessity for an improved channel between Camden and Philadelphia, and the general plan suggested for obtaining such a channel, is stated in the Report of the Chief of Engineers for 1886, pages 806 and 826. The details of the plan as carried into effect are fully stated in the Report of the Chief of Engineers for 1887, pages 790–794.

During the past fiscal year, under an agreement with the American Dredging Company, 20,000 cubic yards of material were removed, at the rate of 12 cents per yard, from the eastern half of the channel in the formation of a cut 120 feet wide and from 10 to 12 feet deep at mean low water. This work was done in the month of August, 1887, and during the balance of the season this deepened channel was maintained without shoaling. An examination just completed shows that a channel of the following dimensions now exists: Six feet deep at mean low water, with a minimum width of 120 feet; 8 feet deep, with a width of 70 feet; and 10 feet deep, with a width of 50 feet. The channel as it exists is maintained by the ebb-tide, and lies with its axis about parallel to and 100 feet north of the lower line of revetment.

As stated in previous reports on this work, it is considered that annual dredging may have to be resorted to in order to maintain the channel at a depth of 10 feet at mean low water.

The object of the revetment is to diminish the annual cost of maintaining this channel. Its gross cost, including superintendence and

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office expenses, was in round numbers $17,000 and it is believed that it will prove of that amount of service to commerce.

In connection with the improvement of the channel across Smith's Island Bar, attention is called to the subject of the removal of the islands and adjacent shoals lying between Philadelphia and Camden as set forth in the report on "the Delaware River between Philadelphia, Pa., and Camden, N. J.

Should the improvement of this part of the river be specially undertaken by the acts of Congress, no further appropriation would be required for the improvement of the channel across Smith's Island Bar.

In the best interests of the work and of commerce it is recommended that all funds for the improvement of the main channel of the Delaware River should be hereafter appropriated under the general title of "Improvement of Delaware River, Pennsylvania and New Jersey." The improvement recommended by the Board of 1884 is the formation of a channel from a point in the river near the upper part of Philadelphia to deep water in the Delaware Bay, with a least width of 600 feet, and having a depth of 26 feet at mean low water. This is to be accomplished, except at Schooner Ledge, where solid rock is to be removed, by means of regulating and contracting works, aided where necessary by dredging. The estimated cost of the work recommended is about $2,425,000. This estimate is exclusive of the cost of any improvement of that part of the river between Bridesburg and Trenton, for which a project and estimate are yet to be submitted. It is also exclusive of any expenditures for the formation of an improved cross-river channel between Philadelphia and Camden.

An appropriation of $600,000 towards carrying into effect the project of 1884 is recommended for the fiscal year ending June 30, 1890, to be applied to dredging and dike construction, together with any necessary surveys and observations, all in accordance with the projects for the permanent improvement of Delaware River and Bay.

The Delaware River is tributary to the following collection districts: Trenton, Philadelphia, Delaware, and Bridgeton.

The amount of revenue collected in these districts during the year ending December 31, 1887, was $17,880,673.80.

Total amount appropriated for improvement of Delaware River from 1836 to June 30, 1888	$1,762,000.00
Total expenditures to June 30, 1888	1,691,564.89
Total amount appropriated on present project to June 30, 1888	410,000.00
Total expenditures on present project to June 30, 1888	339.564.89

Money statement.

July 1, 1887, amount available		$94,594.64
July 1, 1887, covered by existing contracts		43,581.98
		138,176.62
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	$67,741.51	
July 1, 1888, outstanding liabilities	8,195.58	
July 1, 1888, amount covered by existing contracts	36,205.04	
		112,142.13
July 1, 1888, balance available		26,034.49
Amount appropriated by act of August 11, 1888		250.000,00
Amount available for fiscal year ending June 30, 1889		276,034.49
Amount (estimated) required for completion of existing project		1,965,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals for furnishing and depositing stone in constructing a dike in Delaware River near Mifflin Bar, opened April 27, 1888, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard.
1	John Satterlee, Englewood, N. J	$1.98
2	Brandywine Granite Company, Wilmington, Del	1.75
3	George R. Stephenson, Lapidum, Md	2.10
4	Joseph E. Spencer and W. W. Virdin, Lapidum, Md	2.05
5	Joseph H. Ward, Ridley Park, Pa	1.19
6	John A. Bouker, New York, N. Y	1.65

Contract (dated May 3, 1888) awarded to Joseph H. Ward. In progress.

Abstract of proposals for constructing a dike in Delaware River from the lower end of Reedy Island, opened April 27, 1888, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Approximate quantities.		Amount.
		Brush mattress, 4,000 cubic yards.	Stone, 20,000 cubic yards.	
		Per cu. yd.	*Per cu. yd.*	
1	John Satterlee, Englewood, N. J	$1.84	$1.79	$43,160
2	John A. Bouker, New York, N. Y	1.70	1.75	41,800
3	John C. Churchill, jr., Burlington, Vt	1.89	1.74	42,360
4	Ira Lunt, New Castle, Del	1.74	1.54	37,760
5	Brandywine Granite Company, Wilmington, Del	1.55	1.45	35,200

Contract (dated May 3, 1888) awarded to the Brandywine Granite Company. In progress.

COMMERCIAL STATISTICS.

PORT OF PHILADELPHIA.

Domestic and foreign entrances and clearances, 1887.

Class.	Entered from foreign ports.				Cleared for foreign ports.			
	With cargoes.		In ballast.		With cargoes.		In ballast.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
American steam-vessels	15	23,742	2	2,577	13	23,869	4	1,197
American sail-vessels	308	146,005	5	6,779	205	125,025	6	2,513
Foreign steam-vessels	531	706,761	13	17,028	247	358,131	47	33,236
Foreign sail-vessels	490	384,801	13	14,313	515	424,551	18	6,575

Value of exports	$33,813,024
Value of imports:	
Free of duty	5,708,871
Subject to duty	33,863,527
	39,572,398

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Statement of revenue collections.

Year.	Amount received.	Increase for year.
1884	$12,530,451.86	$279,141.34
1885	13,915,553.66	1,385,101.80
1886	16,303,918.77	2,388,365.11
1887	17,950,235.10	1,646,316.33

Coastwise entrances and clearances.

Class of vessels.	Entered.	Cleared.
Steamers	1,539	1,819
Ships	19	8
Barks	77	89
Brigs	52	69
Schooners	2,727	2,820
Total	4,414	4,805

Statement of vessel movement to and from Port Richmond Piers, Delaware River front, for the year ending December 31, 1887.

Class.	Number.
Steamer	864
Sailing vessels	1,967
Canal-boats and barges	3,367
Total	6,198

Freight statement.

Received:		
Foreign iron-ore	tons..	415,000
Shipped:		
Coal	do...	1,919,350
Grain	bushels..	3,382,647

Vessels arriving at and departing from the Delaware and Raritan Canal at Bordentown during the year ending December 31, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	720	74,398	660	68,640
Sailing vessels	117	19,824	6	246
Barges	2,763	450,474	1,546	180,945
Rafts	83	6,807	35	8,925
Total	3,683	552,003	2,247	258,756

A total of 5,930 loaded vessels carrying 810,759 gross tons freight. The estimated value of shipments arriving, 552,003 tons, was $12,171,666, and that of departing, 258,756 tons, at $8,320,593, a total of $20,492,259.

The canal collector at Bordentown estimates the tonnage by water to and from Bordentown during the year not entering the canal and therefore not included in the above statement, as follows:

	Tons.
Steamers	30,000
Sailing vessels	2,000
Barges	210,000
Total	242,000

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Statement of vessels passing through the Chesapeake and Delaware Canal to and from Delaware River during the year ending December 31, 1887.

Description.	Arrivals.	Departures.
Steamers	878	891
Sailing vessels	1,611	1,713
Canal-boats and barges	2,051	2,053
Rafts	171	4
Total	4,711	4,631

Freight statement.

Articles.	Received.	Shipped.
Coal.....tons..	208,793	100,127
General merchandise.....do...	344,013	119,134
Total	552,806	219,261

The foregoing information was furnished by the Philadelphia Board of Trade, Mr. F. W. Taylor, of the Philadelphia Grain Elevator Company, Mr. George M. Taylor, auditor freight receipts, Pennsylvania Railroad Company, and Mr. C. L. Nicholson, secretary Chesapeake and Delaware Canal Company.

In obtaining reliable information of the coastwise commerce of the Delaware River the difficulties are much greater than with the foreign commerce, owing to the fact that no official public record is required of the cargoes of coastwise vessels, and the information can only be obtained from the private records of those interested in such commerce. Apart from the objection many might have to the work of furnishing information covering a commerce probably exceeding in value $100,000,000, I find there is objection to making public information of a private character showing to rival interests the amount of business carried on between particular points by certain steam-ship companies.

THE DELAWARE RIVER BETWEEN PHILADELPHIA, PENNSYLVANIA, AND CAMDEN, NEW JERSEY.

By the joint resolution of Congress dated February 17, 1888, the Secretary of War was authorized to appoint a board of three engineers from the United States Army, whose duty should be to examine, in all their relations to commerce, the islands known as Smith's Island, Windmill Island, and Petty's Island, in the Delaware River, between the cities of Philadelphia and Camden, to determine whether these islands or any shoal in the river between or adjacent to the islands constitute an obstruction to the commerce of the Delaware River between the States of Pennsylvania and New Jersey; and with a view to their removal to report a plan with the estimate of cost for such removal in whole or in part, including the probable cost to the Government of said islands.

To carry this resolution into effect $5,000 was appropriated.

As covering the requirements of this resolution the following report of the Board of Engineers was made under date of March 30, 1888:

Money statement.

Amount appropriated by joint resolution of Congress dated February 27, 1888	$5,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	534.72
July 1, 1888, balance available	4,465.28

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REPORT OF BOARD OF ENGINEERS.

PHILADELPHIA, PA., *March* 30, 1888.

SIR: The Board of Engineers constituted by your order of March 10 has the honor to submit the following report:

The instructions to the Board are contained in the joint resolution of Congress, which is quoted in full below:

JOINT RESOLUTION authorizing the Secretary of War to appoint a Board of three engineers to examine and report in relation to the Delaware River between the city of Philadelphia, Pennsylvania, and Camden, New Jersey, and for other purposes.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he is hereby, authorized to immediately appoint a Board of three engineers from the United States Army, whose duty it shall be to examine, in all their relations to commerce, the islands known as Smith's Island, Windmill Island, and Petty's Island, in the Delaware River, between the city of Philadelphia, in the State of Pennsylvania, and the city of Camden, in the State of New Jersey, which Board shall forthwith report to the Secretary of War as to whether said islands or any shoal in the said river between or adjacent to the said islands, or any of them, constitute an obstruction to the commerce of the Delaware River or to the passage of vessels between the said States; and with a view to removing said islands and shoals, to report a plan with the estimate of cost for their removal in whole or in part, and for the improvement of the harbor of the port of Philadelphia, including the probable cost to the Government of said islands so as to secure free and uninterrupted commerce upon the said Delaware River, and the unobstructed passage of vessels to and from and between the said States; and the sum of five thousand dollars, or so much thereof as shall be necessary, is hereby appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to defray the expenses of such survey and report.

Passed the House of Representatives February 17, 1888.

Attest: JNO. B. CLARK, *Clerk.*

The Board met in Philadelphia at 11.30 a. m., March 21, and in the afternoon made a personal examination of the river from the head of Petty's Island to Gloucester, covering about 7 miles of the city front, in company with a number of gentlemen representing the various mercantile bodies and corporations most interested in developing the commerce of the port of Philadelphia.

The Board continued in session the next day, listening to statements made by various parties interested in the proposed improvement and examining the maps of the harbor of Philadelphia.

The Board requested the Philadelphia Board of Trade to furnish it with a statement of the commercial requirements that demand the removal of the islands in front of the city, and also with an estimate of the probable cost of these islands, or so much of them as should be removed.

To enable these papers to be prepared, the Board adjourned to the 28th instant, when it continued its consideration of the subject referred to it, completing its labors on the 30th of March.

The Delaware River in front of the city of Philadelphia was thoroughly surveyed in 1878 for the city, by the United States Coast and Geodetic Survey, and since then the bars or portions of them have been several times surveyed by the United States Engineer Department. Forty-three borings were made in the Delaware River between Cooper's and Kaighn's points in 1874, by Mr. Samuel Melvin, for a bridge company. All of these borings appear to have struck rock at a depth nowhere less than 39 feet below low water, while on the bar just above Smith's Island Rock was only reached at a depth of over 100 feet.

Thirty-three holes were bored in 1883, under the direction of General Weitzel, United States Engineers, on Smith's, Windmill, and Petty's

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islands, to ascertain if at any point on these islands an excavation to a depth of 24 feet below mean low water would reach rock. The conclusion, from the best evidence attainable, is that no removal of rock will be needed to carry out the plan reported by the Board, and the estimates submitted are on that basis. For absolute certainty on this point some further examinations may be required, but the Board does not feel at liberty, considering the urgency of its instructions, to delay making a report for that purpose.

SMITH'S AND WINDMILL ISLANDS AND THE SHOALS ADJACENT THERETO.

Smith's and Windmill islands lie in the Delaware River, between Philadelphia and Camden, opposite the centers of those cities, and about 800 feet from the ends of the Philadelphia Wharves, which are very short here, in no case exceeding 260 feet in length. The two islands are in the State of Pennsylvania, and are separated by a narrow cut about 130 feet wide, maintained by a ferry company. They only slightly exceed a half mile in length; but there are shoals above and below, the the upper one extending 1 mile to Cooper's Point, the upper limit of Camden, having on it less than 6 feet at mean low water. The shoal below the islands is not so long, but for a distance of a half mile below Windmill Island there is less than 12 feet depth upon it at mean low water.

These two islands, with the adjacent shoals, thus practically form a continuous obstruction in the river opposite the centers of the water fronts in both Philadelphia and Camden, extending 1½ miles, if we consider only the portions of the shoals having less than 6 feet of water, or 2 miles if we include all of the shoals covered with less than 12 feet. The width of even the 12-foot channel between this obstruction and the heads of the Philadelphia Wharves, for 1½ miles, is from 750 to 1,000 feet, and the wharves can only be extended by diminishing this width, already too small. The greatest length of these docks is but 260 feet, as stated above, while, as is well known, the larger ocean steam-ships are much longer. The part of the river on the Camden side of the islands is almost useless as a portion of the harbor, as it is thus so thoroughly cut off from the Philadelphia side.

To avoid misapprehension it is proper here to state that there is a depth of over 26 feet at low water in a narrow channel as far up as the wharves of the Reading Railroad.

Near the wharves on the Philadelphia side the depth is much greater than necessary, in some places exceeding 50 feet, and adds greatly to the cost of wharf extension on that important front.

These islands, with their dependent shoals, are to be considered from two points of view. They are certainly a hindrance to the cross-river navigation between Philadelphia and Camden. This, however, is a matter rather of ferriage between the two cities, which could be provided for at a comparatively small cost by one or more revetted cuts. Besides, however, being obstructions as just stated to the cross traffic between Philadelphia and Camden, these islands and shoals practically reduce the width of the Delaware opposite them on the Philadelphia side to about 750 feet.

This channel might be wide enough to accommodate the vessels passing through it were it not for the fact that it is lined with docks, out of and into which vessels must pass, which requires them to swing across the channel. The up and down navigation is also interfered

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with by the cross-river boats. The current on this concave shore is rapid and increases the difficulties of the situation. The heads of the wharves are occupied by boats, and vessels over 260 feet in length in these docks must project into the channel, thus further contracting its narrow limits.

In time of freshets, and especially when the river is filled with running ice, the difficulties are further increased. For the reasons thus given the Board concludes, in the language of the joint resolution, that these islands and shoals do "constitute an obstruction to the commerce of the Delaware River and to the passage of vessels between the States of Pennsylvania and New Jersey."

PETTY'S ISLAND.

Petty's Island, in the State of New Jersey, lies about 2 miles above the head of Smith's Island, the two being almost connected by shoals. It is about 2 miles long and has an area of about 360 acres above low water. The channel between the island and Philadelphia is about 2,400 feet wide at its upper end, gradually diminishing to 1,120 feet at the lower end, where it can legally be further reduced to 1,000 feet whenever the riparian owners choose to extend the wharves on the island.

While this island can not properly be said to be itself a great obstruction to navigation, its existence complicates the situation. Behind it is a channel carrying nearly half the water of the river, which on the ebb tide comes around the island at a great angle with the other channel, forcing the current still more against the concave shore on the Philadelphia side. The effect of this is to increase the velocity of the ebb current where it strikes the Philadelphia shore and to diminish it towards the Camden side, where it is already too small.

Petty's Island, with its present shape and size, is also an obstruction to the navigation of the Delaware to the extent of diminishing the Philadelphia channel at its lower end to about one-half the width at its upper end.

SHOALS ADJACENT TO PETTY'S ISLAND.

The shoal at the lower end of Petty's Island can hardly be deemed an obstruction to navigation so long as Petty's Island remains as at present. If the channel between the lower end of the island and the Philadelphia shore is widened, then it would be necessary also to widen it past this shoal.

Near the upper end of Petty's Island is a large shoal, known as Five Mile Bar, which extends diagonally up and across the river to the Pennsylvania shore. This shoal has less than 6 feet of water on it for more than a mile of its length, and the deepest channel across it, which is very narrow and near Petty's Island, carries less than 10 feet at mean low water. Immediately above it is a deep channel for several miles up the river, a 26-foot channel, at least 200 feet wide, extending up some 3 miles, or more than a mile above the Frankford Arsenal, and an 18-foot channel extending to the upper limits of Philadelphia, 8 miles above the head of Petty's Island, which can be readily increased to a depth of 24 feet by improving one bar.

This shoal is a serious obstruction to the commerce of the Delaware River, cutting off the upper part of Philadelphia, including the Frankford Arsenal, from the advantages of deep-water navigation.

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WHARF OR PORT-WARDEN LINES.

Any plan for the improvement of the harbor of Philadelphia must embrace both shores. If the United States undertakes the improvement of this harbor, it should be on condition that the wharf-lines on both sides of the river be controlled by the Secretary of War. They are at present controlled by two different States, either one of which can change its own at pleasure.

As long as this condition of affairs exists, it is useless to attempt any general scheme of improving this harbor. Only last year the New Jersey Riparian Commissioners advanced their wharf-line 300 feet in front of Camden, and if the islands were removed they might advance it 300 feet farther and prevent the extension of the Philadelphia wharves. At the same time they advanced the wharf-line around Cooper's Point 250 feet, thereby damaging the river if the wharves are ever built out to this line. The present exterior wharf-line at Cooper's Point, established last year, is 800 feet beyond the shore-line of 1843.

This Board is of opinion that the law making the first appropriation for improving the harbor of the port of Philadelphia should place under the Secretary of War the establishment of the wharf-lines on both sides of the Delaware River, from the lower to the upper limit of the city of Philadelphia, giving him power to alter these lines if he deems it necessary, and no money should be expended until he has both present and future control.

PLAN OF IMPROVEMENT.

The obstructions to commerce at Philadelphia, of which complaints are made, have now been stated. Briefly they are: First, the narrowness of the deep-water channel in front of Philadelphia, which renders it difficult for vessels to enter and leave the docks, and makes them at that time obstructions to passing vessels; second, the impossibility of extending the wharves, which are too short, in so narrow a channel; third, the shoals between Camden and Philadelphia, which interfere with free-water communication, this last point, however, being of secondary importance.

The river is able to maintain a single channel with ample depth and about 2,000 feet in width, with a cross-section not far from 55,000 square feet at mean tide.

The best solution of the difficulties complained of would be obtained by forming such a channel along the Philadelphia shore, from Kaighn's Point to Fisher's Point, at a distance far enough from the present wharf-line, not exceeding anywhere about 300 feet, to permit the extension of the wharves and the widening of Delaware avenue at their shore ends.

In executing such a plan the present tidal flow must be maintained, and as the thorough improvemnt of the Five-Mile Bar will ultimately require the closure of the New Jersey Channel south of Petty's Island, it involves the ultimate widening of the Pennsylvania Channel so as to carry all the present tidal flow. It also includes the removal of Smith's and Windmill islands and their shoals.

Smith's and Windmill islands and the adjacent shoals should be removed, so as to give a 26-foot channel, about 1,000 feet wide, alongside the revised Philadelphia wharf-line from Kaighn's Point to the foot of Petty's Island. If in the progress of the work it is found a wider deep channel can be maintained, it may ultimately be advisable to increase the 26-foot channel to 1,500 feet width.

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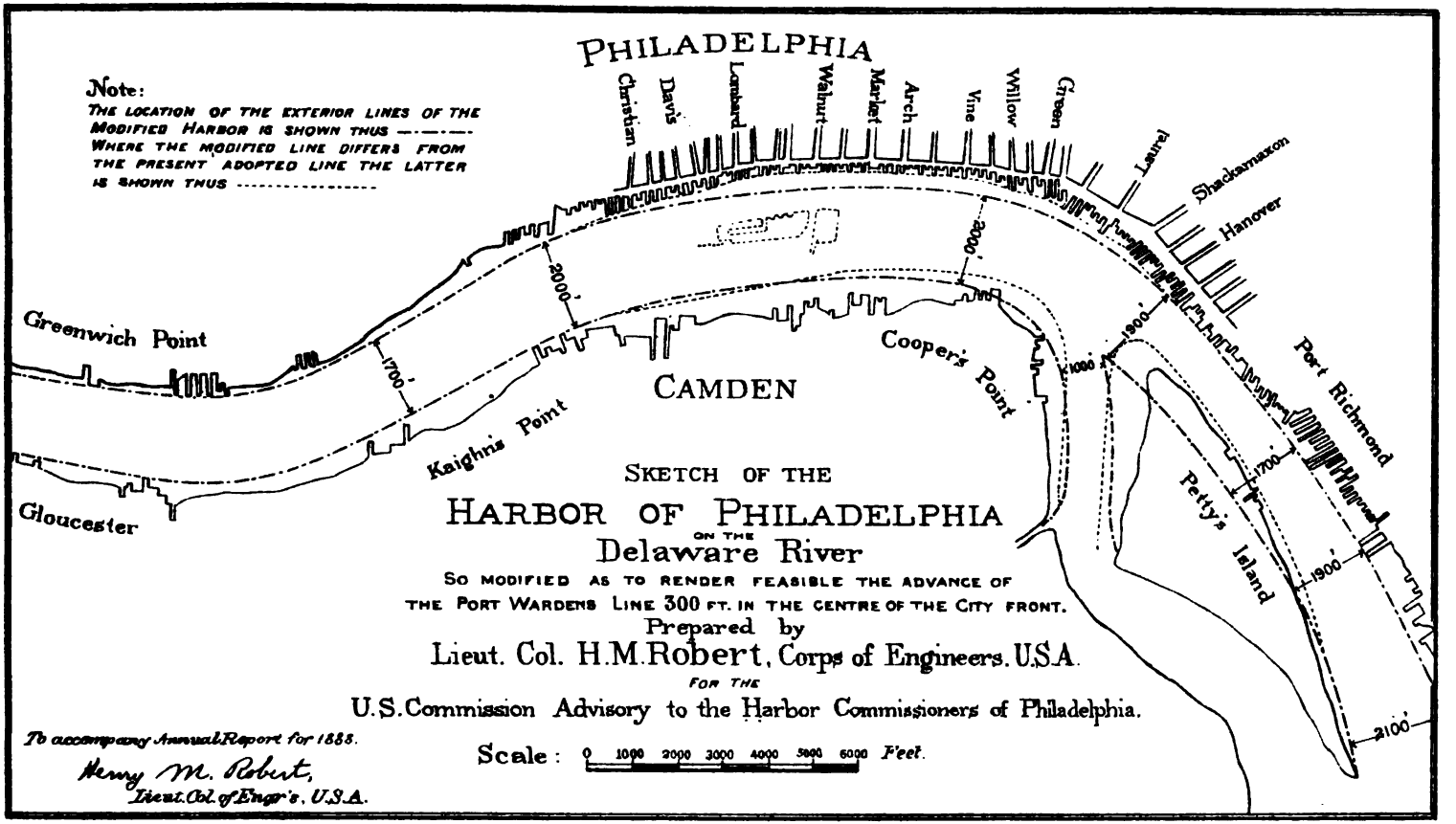

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The estimates are based on a slope of 1 on 25 rising from the eastern edge of this 26-foot channel and on the removal of all of Windmill and Smith's islands and their shoals lying above 12 feet below mean low water.

The ultimate improvement of the Pennsylvania Channel at Petty's Island so as to carry the whole tidal flow will require a water cross-section of about 55,000 square feet at mean tide, and can be obtained by giving it a width of 1,000 feet with 26 feet depth, the channel sloping from this depth to 12 feet in a further width of about 1,000 feet, thus making the final channel width about 2,000 feet. The estimates are based on these dimensions and on the supposition that the dredging required will be equivalent to full dimensions of channel up to the head of Petty's Island. A considerable amelioration of the Five-Mile Bar could be obtained without the complete closure of the channel south of Petty's Island, and until this complete closure the enlargement of the north channel to its ultimate dimensions proposed above would not be necessary, the only indispensable condition being to leave a combined waterway through the two channels which would not decrease the tidal prism above.

While the estimate of the Board includes the expense of dredging away a portion of Petty's Island and the shoal below it, it is altogether probable that the simple removal of the existing bulkheads on that portion of the island and the extension of the Fisher's Point Dike, as suggested, would enable the river itself to do much of the needed widening. In this connection it is proper to remark that the enlargement of Petty's Island on the Philadelphia side, as now authorized by the riparian commissioners of New Jersey should not be permitted.

The removal of Smith's and Windmill islands should not begin or be carried on without the simultaneous regulation of the port warden's lines of both shores of the river, so as to maintain the assigned section of the new channel, as a failure in this respect would only be followed by the reformation of these islands in whole or in part by the river. Moreover, it is not sufficient that these lines should simply be laid down on paper, but their existence as actual constructions should be a part of the progressive scheme for the proper improvement of this portion of the river.

It has been represented that the extension of the wharves on the Philadelphia side could not be effected by many of their owners on account of the large expense thereof, due to the great depth of the water. If this can not be done at private expense it should be in some other way than by the United States.

When the control of the wharf lines is in the hands of the Secretary of War, they should be revised on both sides of the river, keeping them about 2,000 feet apart, and allowing the Philadelphia wharves in the center of the city to be extended about 300 feet.

The Board does not consider that it is required by its instructions to submit a detailed plan of wharf lines, especially as this would require a greater delay than is consistent with those instructions.

The material to be removed should be placed where it will not be an injury to the river. League Island, the site of the navy-yard, contains about 400 acres of land within the dikes which is about 3 feet below ordinary high tides. Its value would be enhanced by its being raised several feet above high water.

At Howell's Cove, in the Horse Shoe, a large amount of the material could be deposited with advantage to the river, by protecting the front with a bulkhead.

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The riparian owners of the Camden shore would doubtless be glad to get a portion of the material for filling up the large space between the present shore line and the authorized line of solid wharf filling.

The Board has not had the means in so short a time, from its own investigations, to reach a conclusion as to "the probable cost to the Government of said islands," and, in view of the urgency of the instructions requiring prompt report, does not feel at liberty to delay its renditions further.

Should the city of Philadelphia, whose local interests are so intimately and specially connected with the matter, purchase the islands as a preliminary to their removal, the cost of acquiring them would to the United States be nothing.

It is probable the sum that it would be necessary to pay for those islands would not be less than the amount ($600,000), estimated therefor in the letter of March 23, from the Board of Trade, hereto appended.

This Board does not feel called upon to make any recommendation as to the process to be followed in obtaining possession of the islands in question, as the details of such business will doubtless be managed under proper legal direction.

The estimated cost of dredging to be ultimately done to carry out the plan of the Board is $3,500,000.

The papers mentioned below are sent herewith.

(1) Communication from the Board of Trade of Philadelphia, dated March 23, 1888, and inclosing a number of resolutions from representative bodies.
(2) Letter of Board of Trade dated March 29, 1888, referring to No. 1.
(3) Letter from Board of Trade dated March 28, 1888, inclosing letter of Hon. W. J. Sewell, who incloses certain resolutions of the State of New Jersey and council of Camden, N. J.
(4) Letter from Board of Trade dated March 29, 1888, inclosing description of a public meeting held in Philadelphia in November, 1887.
(5) Letter of March 28, 1888, from Hon. Leonard Myers, attorney for Mr. William Longstreth.

WM. P. CRAIGHILL,
Colonel of Engineers.
C. B. COMSTOCK,
Lieut. Col. of Engineers, Bvt. Brig. Gen.
HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

STATEMENT OF BOARD OF TRADE OF PHILADELPHIA, PENNSYLVANIA.

OFFICE OF THE BOARD OF TRADE,
MERCANTILE LIBRARY BUILDING,
Philadelphia, March 23, 1888.

SIR: The Board of Trade is in receipt of your communication of March 20, 1888, asking a statement of the facts that demand the removal of Smith's, Windmill, and Petty's islands and the advantage to commerce resulting therefrom, and also a statement of the probable cost to the Government of the islands or such portion as it may be necessary to remove.

In reply I would state in behalf of the Board of Trade that representing the commercial interests of the city and port of Philadelphia, and in obedience to a strong demonstration of public sentiment on the subject, the board early in 1887 started the movement for the removal of the islands. In this it has been ably seconded and supported by all the commercial and maritime organizations of the city and port, to wit, the Commercial Exchange, the Maritime Exchange, the Drug Exchange, the Grocers and Importers' Exchange, and the Vessel-Owners and Captains' Association. It has also been supported by the board of wardens for the port of Philadelphia representing the State of Pennsylvania as custodians of its interests in the water-ways in front of Phila-

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delphia, and finally by the city councils of Philadelphia, and their board of harbor commissioners representing the municipality.

All of these bodies have adopted resolutions favoring the improvement of the harbor by the removal of the islands, under the supervision and authority of the General Government, and have appointed committees to further the purposes of their resolutions, copies of which are hereto annexed. A meeting of wharf-owners, merchants, and others interested, was held on November 29, 1887, at which a strong expression of public sentiment was obtained in advocacy of the removal.

The press of Philadelphia has also been uniform in its earnest expression of the necessity of removing these islands in order to improve the commerce and maritime interests of the port.

We will premise briefly a statement of the geographical location of Philadelphia. The city stands upon a navigable river of large dimensions, and is the terminus of three great railways leading from the interior to the sea-board, and having together some 15,000 miles of line, besides a vast amount of additional lines connecting with them. These railroads extend to the remotest part of the great West and Southwest, and pour out millions of traffic to be shipped from our wharves. The foreign trade last year alone amounted to upwards of $66,000,000, besides a vast coastwise commerce in coal, lumber, grain, wool, and domestic products, this being one of the largest coal-shipping ports of the country. The amount of duties paid on imports for 1887 was $17,640,944.

The channel of the Delaware River between Philadelphia and the sea has been extensively improved by the Government by dredging and a thorough system of lighting, so that it is now capable of accommodating the largest ships of modern commerce safely and expeditiously. With these facilities of egress and ingress it would seem unfortunate to have the immediate harbor of the city so cramped and restricted as to imperil and curtail the facilities of handling the commerce for which so much trouble has been taken to provide a channel. The advantages of Philadelphia as the leading fresh-water port on the Atlantic sea-board are well known as one of the attractions that make it a favorite haven with ship-masters.

The city of Philadelphia is shaped like an hour-glass, the narrowest portion being at Market street. The Delaware River flows by a crescent-shaped channel past its wharves, giving the business section of the city a concave front, opposite to the center of which and in the midst of the river are located Smith's and Windmill islands, with the adjacent shoals stretching to Petty's Island about a mile above, which by its location unfavorably influences the entire river channel. The main mercantile business portion of Philadelphia is situated between Vine and South streets, and the great stores and warehouses are in or near this section. With the sharp competition prevailing in all classes of business it is absolutely necessary that the cost of handling should be reduced to a minimum by reducing the distance of hauling, and that the freight forming cargoes should be moved between warehouse and vessels at the smallest possible expense.

Philadelphia being the leading manufacturing city of the United States, an enormous traffic grows out of the imports of raw materials and the export of unmanufactured goods. The commerce naturally concentrates in front of the central portions of the city, because the extreme upper end is not readily accessible on account of the shallowness of the water, while the lower end is mainly a marshy region that can only be used for such wharves as are made railway terminals for through traffic, and are unavailable for the business originating in or designed for the city itself.

The public wharves of Philadelphia available for the use of vessels bringing dry cargoes are limited to four in number, viz, Piers 34, 35, 38, and 39, South Wharves, and even these are below the business section above described. These wharves are all extended out to the port warden's line, but are nevertheless insufficient in length to allow enough platform space on which to place even an ordinary cargo at once, and vessels are therefore compelled to stop in their unloading until such room is made on the wharf by consignees removing their merchandise as will admit continuing the work of discharge.

As an instance of this loss of time to vessels, take a steamer coming here with a cargo of fruit, general merchandise, or sugar. It seldom happens that she is unloaded in less than eight days after arrival, whereas in New York, Boston, or Baltimore she would be unloaded in two or three days, for the reason that in those cities wharves are sufficiently long, large, and properly protected from the weather, whereas the public wharves of Philadelphia can lay claim to none of these important features—important not only for the above reasons, but because a ship-owner can save money by reducing wharfage charges and securing dispatch, and would therefore naturally send his vessel to the port where advantages such as these can be secured.

The average length of steamers that now visit Philadelphia is from 290 to 325 feet; the dock length of Pier 34 is 284 feet; of Pier 35, 295 feet; of Pier 38, 282 feet, and of Pier 39, 310 feet, from which it will be seen that the damage done steamers by floating ice and vessels moving up and down the river in a fog can be ascribed to the inability

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of long vessels to go into these short docks far enough to be protected from these dangers.

The piling and bed work of these wharves are too old and decayed to admit of the docks being dredged to sufficient depth to allow of vessels remaining afloat at all stages of the tide, and it is fair to assume that the depth of water in these docks during the year does not exceed an average of 17 feet at low water, or 22 feet at high water, whereas vessels that now come here require 18 to 24 feet of water to keep them afloat and free from hard substance at the bottom of docks, making grounding dangerous, and in violation of all terms of charter-party or agreement as to freighting, insurance, etc., which stipulate a vessel must remain afloat at all hours of the tide. It likewise often happens that steamers are unable to unload and load their cargoes through being aground and the consequent inability to secure water for their engines to make steam.

At the end of these docks, outside of the port warden's line, may be found 40 to 60 feet of water in the channel.

The width of the channel at this point is only 500 feet, and it has happened that vessels of 275 to 325 feet length coming out of these docks have been unable to turn in this width of channel, and have touched the bar on the eastern side. With the exception of the four wharves above mentioned, all the others in front of the business section (and they are all of less length) are controlled by sugar refineries, steam-ship companies, railroads, ferries, etc., for their individual use.

In front of the business section, where these short piers now exist, the location of Smith's and Windmill islands entirely prevents their being lengthened, as the channel is now so narrowed as to but inadequately accommodate existing commerce. On the contrary, were the islands removed and the thread of the river changed the piers could be extended, and Delaware avenue, which leads to them, widened, thus accommodating the larger vessels which are now compelled to berth themselves at a greater distance from the business centers, subjecting the traffic to a much increased expense and the vessel to great delays. The widening of the avenue and the lengthening of the piers, we understand, will be provided independently of the Federal Government, both the city and wharf-owners being anxious for the improvement. In large part it is already available for much of the improvement through the liberality of one of Philadelphia's most noted citizens and merchants, the late Stephen Girard.

The islands referred to are a great obstruction to the cross-river traffic between Philadelphia and New Jersey, which the Government has by repeated expedients endeavored to remedy, though with but partial success. Not only is there a large freight traffic transferred, which in 1887 reached 1,000,000 tons by the various railroads and ferries, but also an enormous passenger traffic on the ferry-boats, which in 1887 exceeded 42,000,000 of people. All of these are seriously inconvenienced by the delays and impediments of crossing the river under the present disabilities. All this vast trade, as well as that moving up and down the river, has to be cared for in a channel so blocked up by the islands and shoals that its proper handling is seriously interfered with and the commerce of the city discouraged and retarded. The islands are declared in resolutions adopted by this board to "stand as permanent barriers to the future improvement of our valuable river frontage, and threaten most seriously the commercial welfare of our great city."

We annex a letter of the harbor master of the port of Philadelphia, an officer of the State of Pennsylvania and practical navigator, describing this subject, which tersely recites the difficulties alluded to, and suggests a similar remedy.

The improvement of the Philadelphia Harbor, as universally desired by all the interested parties, is a removal of the islands and shoals now obstructing the river and the establishment of a new wharf line by the authority of your Board for both sides of the river. It is desired that the Philadelphia wharves may be extended to a proper length so that the increasing commerce of the city may be adequately accommodated and the existing difficulties may be remedied, and also that the traffic between the two States be made easy and direct across a river entirely free from obstructions.

The network of railways ramifying through the New Jersey peninsula and terminating opposite the city of Philadelphia will be vitalized by larger, more efficient, and economical terminals, and the cross-river transit could then be made possible in a shorter time by more capacious ferry-boats than can now be used. An extensive water-front could also be reclaimed on the New Jersey shore and made available for commercial purposes.

In reference to your request for "a statement of the probable cost to the Government" of the islands in question, we find this difficult to answer, for the reason that they are a species of property, and, as they at present exist, of entirely different character from any other property in or near Philadelphia. It is therefore almost impossible to get competent estimates of value from any but directly interested parties, although the amount stated below is the result of careful investigation and examination assisted by the opinions of leading real-estate experts in Philadelphia.

Petty's Island is in the jurisdiction of the State of New Jersey, and the part that would probably be wanted is owned by several interests, a portion not being improved

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and the remainder having some improvements. A map showing the property ownership is hereto annexed.

Smith's Island is mainly occupied as a summer resort for public recreation, having been purchased a few years ago, it is understood, for $55,000, after which a large sum was spent for improvements. The present owner is understood to have heretofore made a considerable annual profit from his ferry, admission fees, and the sales of liquor, privileges, etc.; but the fact of the liquor license being already refused from and after June 1, next, may curtail this profit for the approaching season, and reduce materially his idea of the value of the investment. A portion of Smith's Island, exceeding 1 acre, is the property of the Pennsylvania Railroad.

Windmill Island is largely owned and controlled by Messrs. Tatham & Bros. and the Philadelphia and Reading Railroad, and is mainly unoccupied. Upon a part of it are some manufacturing establishments. We make the following estimates of value from the best information obtainable:

Petty's Island (about 20 acres), Smith's and Windmill islands, estimated total cost about $600,000.

All of which is respectfully submitted.

I have the honor to be, yours truly,

FRED. FRALEY,
President the Philadelphia Board of Trade.
W. R. TUCKER,
Secretary.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers,
Chairman of Board of Engineers.

RESOLUTIONS OF BOARD OF DIRECTORS OF THE VESSEL-OWNERS AND CAPTAINS' ASSOCIATION.

VESSEL-OWNERS AND CAPTAINS' ASSOCIATION,
Philadelphia, December 7, 1887.

At the regular monthly meeting of the board of directors of the Vessel-owners and Captains' Association, held on the above date, the following resolution was unanimously adopted:

"*Resolved*, That the board of directors of the Vessel-owners and Captains' Association hereby cordially indorse the movement for the improvement of the harbor of Philadelphia by the removal of Smith's and Windmill islands from the channel of the Delaware River.

"*Resolved*, That a committee of five members of this Board be appointed to co-operate with similar committees from different commercial and maritime bodies, should the harbor commission and its board of scientific advisers determine upon a feasible plan of removal."

The chair appointed committee, Messrs. Colton, Cook, Parker, Baymore, and Henry D. May.

Extract from the minutes.

Attest.

[SEAL.]

J. F. WALLACE,
Secretary.

EXTRACTS FROM THE MINUTES OF THE BOARD OF WARDENS FOR THE PORT OF PHILADELPHIA.

OFFICE OF THE BOARD OF WARDENS FOR THE
PORT OF PHILADELPHIA,
Philadelphia, March 21, 1888.

Regular stated meeting, December 5, 1887.

Mr. Cook offered the following:

"Whereas there has been a strong expression of opinion by commercial and maritime interests of Philadelphia in favor of improving the harbor by the removal of Smith's and Windmill islands from the Delaware River and the extension of the piers in front of the city, so that they will adequately accommodate the larger vessels now employed in commerce.

"*Resolved*, That the board of wardens for the port of Philadelphia hereby expresses its opinion as in favor of such action should the board of harbor commissioners and the advisory board of scientific men decide that it is feasible, and agree upon and recommend a satisfactory plan.

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"*Resolved*, That this board further expresses the opinion that said plan should not overlook the legal rights of the wharf-owners on the Delaware River front, which it is the duty of the wardens to supervise, and should recognize the ownership by the State of Pennsylvania of all the riparian rights not given to private owners, under the laws of the State, and that it should also include a comprehensive system of improvement of the Delaware front of the city by the aid, in whole or in part, of the city government, supplementing the work by private owners as well as the removal of the islands referred to and the adjacent shoals.

"*Resolved*, That a copy of these resolutions be transmitted to the board of harbor commissioners."

Unanimously adopted.

Special meeting, January 9, 1888.

The following was offered by Mr. Cook:

Resolved, That a special committee of five be appointed to report to the board, under the resolution passed at the December meeting, in the matter relating to the proposed removal of Smith's and Windmill islands."

Adopted.

On motion, the secretary was instructed to forward copies of the resolution to the Board of Trade, Harbor Commissioners, Maritime Exchange, Commercial Exchange, and the Vessel-owners and Captains' Association.

The committee was appointed as follows:

Messrs. Cook, Ferguson, Wilson, Norman, and Halyburton.

True copy.

Attest:

GEORGE A. COTTON,
President.

[SEAL.]

JONA GILLINGHAM,
Secretary.

LETTER FROM HARBOR MASTER OF PHILADELPHIA, PENNSYLVANIA.

COMMONWEALTH OF PENNSYLVANIA,
OFFICE OF THE HARBOR MASTER OF PHILADELPHIA,
Philadelphia, March 22, 1888.

DEAR SIR: The port of Philadelphia is seriously crippled by reason of the limited lengths of the wharves and the crowded condition of Delaware avenue.

Neither of these troubles could be remedied without the removal of the islands. The channel between them and the ends of the wharves is so narrow that the wharves could not be extended, and the only practical way to widen Delaware avenue would be to bulkhead the heads of the docks and fill in to the width required.

If the islands were removed and the port warden's line extended, say, about 300 feet at Market street, the wharves could be run out to that point, and after widening the avenue as suggested we could have docks about 450 feet in length and be able to accommodate any and all kinds of vessels that might visit our port.

The wharves were built years ago to suit the vessels of that day, and while they answered the purpose then, they must be altered now.

It goes without saying that vessels like those of the present day, ranging from 300 feet to 450 feet in length, can not be afforded the proper facilities for loading or discharging or be safely moored to a wharf but 200 feet or 250 feet long.

During the past year numbers of large steam-vessels were anchored at all times in the vicinity of Gloucester, N. J., waiting their turns to haul into the few wharves at the lower part of the city that could receive them to discharge their cargoes. That should not be so in a port like this. All delays add to the expense of transportation, and vessels would not be chartered to come here at the same rates as they would be if the proper accommodations were at their disposal.

If the islands were removed so that the wharf owners could extend, the commerce would be largely increased, and the large amount paid in the way of duties, etc., would be proportionately enlarged.

The people of Philadelphia are anxious to have the needed improvments, and ready to do their share.

Yours, very truly,

CHARLES LAWRENCE,
Harbor Master.

WILLIAM R. TUCKER, Esq.,
Secretary Board of Trade.

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LETTER FROM THE SECRETARY OF THE PHILADELPHIA DRUG EXCHANGE.

PHILADELPHIA DRUG EXCHANGE,
Philadelphia, March 23, 1888.

DEAR SIR: In reply to your request, I herewith submit the following extracts from the minutes of the board of directors of this association, regarding the subject of the proposed removal of Smith's and Windmill islands from the Delaware River, viz:

[Extract from the minutes, December 14, 1887.]

"A communication from the Philadelphia Maritime Exchange under date of November 25 was read, regarding the removal of Smith's and Windmill islands from the Delaware, and requesting the appointment of a committee to join in a conference with similar committees from other trade associations to consider the matter.

"The president announced that said committee should consist of Messrs. John Fergusson, Edward H. Hance, and Richard M. Shoemaker."

[Extract from minutes, February 8, 1888.]

"Mr. John Fergusson, from committee on navigation of the Delaware River, reported that, in company with Mr. Shoemaker, he had met the committee on commerce of the select councils on January 30, and had expressed the views of the drug exchange in the matter 'as being in hearty accord with the other mercantile bodies," after which it was resolved that the chairman be authorized to proceed to Washington, should occasion require, and represent the association before the Congressional committee."

On March 14 the joint report of the several committees, bearing date February 17, was received, of which you already have a copy. This (the drug exchange) committee was then discharged from the further consideration of the subject.

[SEAL.] WILLIAM GULAGER,
Secretary.

Mr. W. R. TUCKER,
Secretary of the Board of Trade.

PREAMBLE AND RESOLUTIONS OF THE PHILADELPHIA BOARD OF TRADE.

OFFICE OF THE BOARD OF TRADE,
Philadelphia, March 23, 1888.

The board at its meeting held January 17, 1887, unanimously adopted the following preamble and resolutions:

Whereas the increasing commerce of Philadelphia demands enlarged wharf facilities for vessels of the great capacity now engaged in our coastwise and foreign trade; and

Whereas it is a notorious fact that there are few but piers with length enough to accommodate safely the large vessels now trading to this port, and if it be desired to retain our commerce some speedy and radical measure must be adopted to secure the extension of our wharves to meet the demands of the day; and

Whereas the further extension of the port warden's line under the existing condition has been declared by recognized authorities unwise and dangerous, thus restricting the length of our wharves to their present inadequate dimensions; and

Whereas Smith's and Windmill islands stand as permanent barriers to the future improvement of our valuable river frontage and threaten most seriously the commercial welfare of our great city: Therefore,

Be it resolved, That the president of the board be requested to appoint a committee of five members to take into consideration the feasibility of the removal of Smith's and Windmill islands and the adjacent shoals.

Resolved, That the said committee on the "removal of Smith's and Windmill islands" be authorized to confer with committees of the Commercial and Maritime Exchanges and such other organizations as it may deem wise and proper.

The following committee was appointed by the president: Messrs. John Price Wetherill, Henry Winsor, Benjamin S. Janney, jr., E. K. Stevenson, and William Brokie.

True copy.

W. R. TUCKER,
Secretary.

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MEMORIAL TO CONGRESS FROM DIFFERENT TRADE ORGANIZATIONS OF PHILADELPHIA, PENNSYLVANIA.

OFFICE OF THE PHILADELPHIA BOARD OF TRADE,
Philadelphia, ——— ——, 18—.

Copy of memorial adopted at a meeting of representatives of the Board of Trade, Commercial Exchange, Maritime Exchange, Drug Exchange, Grocers and Importers' Exchange, Vessel-owners and Captains' Association, and the wardens of the port of Philadelphia, held at the Board of Trade rooms February 10, 1888, at the call of Mr. John Price Wetherill, chairman of the special committee of the Board of Trade on the removal of Smith's and Windmill islands.

To the honorable the Senate and House of Representatives in Congress assembled:

This joint memorial of the Board of Trade, the Commercial Exchange, the Maritime Exchange, the Drug Exchange, the Grocers and Importers' Exchange, the Vessel-owners and Captains' Association, and the wardens of the port of Philadelphia, representing in their membership the various mercantile and trade interests of the city of Philadelphia, respectfully represent that they are thoroughly impressed with the great importance of furnishing to the coastwise and foreign commerce of Philadelphia the greatest facilities for the economical handling of vessels and their cargoes.

That by reason of the existence of the present conditions of the Delaware River the further lengthening of the piers on that river in front of our city can not be undertaken without offering an obstruction to the navigation of said river. This is a matter deserving the most serious attention when we consider the limited number of piers that are of sufficient length to accommodate the enlarged vessels of the present day.

That the subject of the improvement of our harbor has been ably considered and reported on by the United States Advisory Commission to the harbor commission of Philadelphia, which commission will not advise the greater extension of the piers between Washington avenue and Willow street until Smith's and Windmill islands and the shoals above and below them are removed; and further report that any project for the extension of wharves and the removal of the islands should be comprehensive enough to include the improvement of the harbor from the head of Petty's Island to the lower end of the shoals, and also the control of the wharf lines on both sides of the river.

That the city councils of Philadelphia have accepted and adopted the report of the harbor commissioners, with the recommendations of the United States Advisory Commission.

That we, representing our merchants and tradesmen, firmly believe the conclusions of the United States Advisory Commission to be wise, and that we can only hope for ample harbor facilities by the removal of the islands in question, which stand alike in the way of harbor improvements and as obstructions to the free intercourse between the States of Pennsylvania and New Jersey; therefore your memorialists, the Board of Trade, the Commercial Exchange, the Drug Exchange, the Grocers' and Importers' Exchange, the Vessel-owners' and Captains' Association, and the wardens of the Port of Philadelphia most earnestly petition your honorable bodies for the enactment of such a law as will early permit, under the direction of the proper authority, the removal of the islands now obstructing the navigation and commerce of our river Delaware and retarding the improvement of the harbor of the port of Philadelphia.

And your memorialists will ever pray, etc.

True copy.

W. R. TUCKER,
Secretary.

PHILADELPHIA, *March* 23, 1888.

PREAMBLE AND RESOLUTION OF THE BOARD OF DIRECTORS OF THE PHILADELDHIA MARITIME EXCHANGE.

THE PHILADELPHIA MARITIME EXCHANGE,
OFFICE OF THE SECRETARY,
Philadelphia, Pa., March 23, 1888.

PROPOSED REMOVAL OF SMITH'S AND WINDMILL ISLANDS, ETC.

On January 17, 1887, the board of directors of this exchange unanimously adopted the following preamble and resolution:

"Whereas there is an urgent necessity for better wharfage accommodation on the Delaware River front in the neighborhood of the business portion of the city; and

"Whereas the warden's line as laid down by the Advisory Board of the Harbor

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Commission prevents any extension of piers at these points, and in some cases recommends their being contracted:

"*Resolved*, That this exchange appoints its pilotage and navigation committee to confer with committees named by the Board of Trade, Commercial Exchange, and other bodies, to consider the feasibility of the removal of Smith's and Windmill islands, with the shoals connected therewith, which now obstruct navigation in the harbor and prevent improvements on the river front."

EDW. R. SHARWOOD,
Secretary.

RESOLUTION ADOPTED BY THE BOARD OF DIRECTORS OF THE COMMERCIAL EXCHANGE OF PHILADELPHIA.

THE COMMERCIAL EXCHANGE OF PHILADELPHIA,
Philadelphia March 26, 1888.

At a meeting of the board ofdirectors of the Commercial Exchange of Philadelphia, held October 27, 1887, the following resolution was unanimously adopted:

"*Resolved*, That the president of the Commercial Exchange be authorized and requested to appoint a committee of five to act in conjunction with the Board of Trade and such other committees as may be appointed by other commercial or trade bodies of our city in carrying out the removal of Smith's and Windmill islands in the Delaware River."

[SEAL.] HARVEY K. HINCHMAN,
President.

C. ROSS SMITH,
Secretary.

APPENDIX TO THE JOURNAL OF SELECT COUNCIL, CITY OF PHILADELPHIA.

[Appendix No. 112.]

PHILADELPHIA, *January* 30, 1888.

To the Select and Common Councils of the City of Philadelphia:

GENTLEMEN: The committee on commerce and navigation, to which was referred a communication from the board of harbor commissioners, submitting for the consideration of your honorable bodies a comprehensive and handsomely indorsed report and plan for the improvement of the harbor and port of Philadelphia, which it is proposed to be accomplished by the purchase of Smith's and Windmill islands and a portion of Petty's Island, and the removal of the two first-named bodies of land in their entirety, and a portion of the latter, together with the shoals adjacent thereto, which is amply and ably set forth by the board of harbor commissioners in their report above alluded to and submitted to councils on the 5th day of January, 1888, and to be found in the appendix of Common Council (No. 185) on said date, respectfully submit that the committee met in select council chamber on the 30th day of January, 1888; to this meeting the harbor commission, Commercial Exchange, Maritime Exchange, Board of Trade, Drug Exchange, the Vessel-Owners and Captains' Association were invited, as well as officers of the Pennsylvania and Reading Railroad companies. The several commercial and maritime bodies and the corporations were represented by gentlemen who made able and exhaustive arguments in support of the report of the harbor commissioners. At the conclusion thereof your committee agreed to submit for your consideration and approval—

First. The resolution approving and indorsing the report of the board of harbor commissioners as submitted by the United States Advisory Commission, recommending the removal of Smith's and Windmill islands and part of Petty's Island and the adjacent shoals, thereby permitting the extension of the wharves of the city, and memorializing Congress to make the improvements as suggested by appropriating moneys to purchase the islands and do the work.

Second. A resolution requesting the commercial and maritime bodies and corporations interested to co-operate with councils and this committee in urging the matter of the improvement of the harbor by the removal of the islands.

JAMES A. FREEMAN, *Chairman.*
WILLIAM MCMULLEN.
J. B. VAN DUSEN.
EDWIN S. STUART.
SAMUEL HART.
GEO. L. HORN.
A. E. JONES.
JOHN E. HANIFEN.
THOMAS J. RYAN.
JOHN B. DALLAS.
GEO. L. PFOUTS.
HAROLD MANN.
JAMES P. PARK.
A. C. PATTERSON.

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Resolution indorsing and approving the report of the board of harbor commissioners in the matter of the improvement of the harbor of Philadelphia, and memorializing Congress to authorize the improvements suggested in said report.

Resolved, That the select and common councils of the city of Philadelphia hereby approve and indorse the report of the board of harbor commissioners, recommending a plan for the improvement of the harbor of Philadelphia, as submitted by the United States Advisory Commission, by the removal of Smith's and Windmill islands and part of Petty's Island and the adjacent shoals, thereby permitting the extension of the wharves in front of the city; and

That the following memorial be presented to Congress upon the subject:

To the honorable the Senate and House of Representatives in Congress assembled:

This memorial of the select and common councils of the city of Philadelphia respectfully represents—

That there is demanded at the port of Philadelphia enlarged wharf facilities for the larger vessels of greater capacity now engaged in the transportation of freight, both foreign and coastwise.

That there are now but few piers with sufficient length to safely accommodate the large vessels of the class above mentioned, this being a matter of serious consideration and one vitally affecting the future commercial prosperity of our city and State.

That the city councils, through their board of harbor commissioners, have had under consideration the report of the United States Advisory Commission to the said Commissioners, which Advisory Commission has made a careful and thorough study of the subject of the improvement of the harbor, and submit as their conclusions that an extension of the piers between Washington avenue and Willow street, without injury to the harbor, can only be made by the removal of Smith's and Windmill islands and the shoals above and below them; and also that any plan for the removal of these islands and the extensions of the piers should be comprehensive enough to include the improvement of the harbor from the head of Petty's Island to the lower end of the shoals, and the control of the wharf lines on both sides of the Delaware River.

That the city councils are satisfied that the conclusions arrived at by such an able commission are wise, and that they receive the indorsement of those most deeply interested in the commercial prosperity and advancement of the port of Philadelphia: Therefore,

Your memorialists, the select and common councils of the city of Philadelphia, most earnestly petition your honorable bodies to enact such a law as will authorize the Secretary of War, through the United States Corps of Engineers, to early commence the improvement of the harbor of Philadelphia in manner as set forth in this memorial.

Resolution requesting and authorizing the committee on commerce and navigation, in conjunction with the harbor commissioners and other bodies, to urge upon Congress the matter of the improvement of the harbor and port of Philadelphia.

Resolved by select and common councils of the city of Philadelphia, That the committee on commerce and navigation, in conjunction with the board of harbor commissioners, board of port wardens, the several commercial and maritime organizations of the city, and representatives of the Pennsylvania and Reading Railroad companies be, and are hereby, requested and authorized to urge upon the Senate and House of Representatives of the United States the importance of the adoption of such legislation as will assist in carrying out the suggestions relative to the improvement of the harbor and port of Philadelphia, as set forth in the report of the Board of Harbor Commissioners, submitted to councils on January 5, 1888, and printed in the appendix of that day.

LETTER OF THE SECRETARY OF THE PHILADELPHIA BOARD OF TRADE.

OFFICE OF THE BOARD OF TRADE,
Philadelphia, March 29, 1888.

SIR: In reply to your request that the Board of Trade should revise its estimate of the probable cost to the Government of the islands to be removed in the improvement of our harbor, by reason of the error made in submitting the acreage of the part of Petty's Island required, I would state that I find the parties furnishing the Board with the estimated value of that portion of Petty's Island made their calculations on the basis of the value of the property contained outside of the line drawn by the United States Advisory Commission to the board of harbor commissioners, and not

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on the basis of the number of acres submitted in your communication of the 20th instant.

The Board therefore finds it unnecessary to amend its original estimate as presented to you in its communication under date of the 23d instant.

I remain, sir, your obedient servant,

W. R. TUCKER,
Secretary.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers, Chairman, etc.

LETTER OF THE SECRETARY OF THE PHILADELPHIA BOARD OF TRADE,

OFFICE OF THE BOARD OF TRADE.
Philadelphia, March 28, 1888.

SIR: I again address you, in order to forward a letter of the Hon. William J. Sewell accompanying copies of resolutions passed by the legislature of the State of New Jersey and the city council of Camden, in the State of New Jersey, relative to the necessity of the removal of the islands now obstructing the harbor of the port of Philadelphia.

This, and the inclosures, I would be pleased to have you consider as a supplement to the communication addressed to you by this Board of Trade under date of the 23d instant.

I have the honor to remain, sir, your most obedient servant,

W. R. TUCKER,
Secretary.

Col. WM. P. CRAIGHILL,
Corps of Engineers, Chairman, etc.

LETTER OF THE HON. W. J. SEWELL.

CAMDEN, N. J., *March* 27, 1888.

MY DEAR SIR: I beg to inclose you, at the request of Mr. Geo. B. Roberts, a certified copy of resolution, relative to removal of obstructions in the Delaware River, which passed the legislature of the State of New Jersey; also one on this subject which passed the city council of Camden.

I would further state that the riparian commission of New Jersey, some months ago, in view of the proposed removal of these obstructions, changed the riparian line in front of Camden, advancing the same 300 feet.

Very respectfully, yours,

W. J. SEWELL.

Mr. WM. R. TUCKER,
Secretary Board of Trade, Philadelphia.

JOINT RESOLUTION OF THE LEGISLATURE OF THE STATE OF NEW JERSEY.

STATE OF NEW JERSEY:

Joint resolution requesting Congress to make an appropriation for the removal of Smith's or Windmill Island from the Delaware River.

Whereas the navigation of the Delaware River between the cities of Camden, in the State of New Jersey, and Philadelphia, in the State of Pennsylvania, is impeded and obstructed by the island known as Smith's Island, or Windmill Island, located near the center of said river, to the great loss, inconvenience, and damage to the citizens of this State, and of the State of Pennsylvania: Therefore,

1. *Be it resolved by the senate and general assembly of the State of New Jersey*, That the Senators and Representatives in Congress from this State are earnestly requested to support and use their influence with the present Congress for an appropriation of sufficient money to defray the expense of an examination of the island in the Delaware River between the cities of Philadelphia and Camden, with a view to the removal of

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said islands, which not only impede and obstruct the navigation of said river, but are the occasion of great loss, inconvenience, and damage to the citizens of this State and of the State of Pennsylvania.

2. *And be it resolved*, That copies of this resolution be forwarded to the Senators and Representatives in Congress from New Jersey by the secretary of state.

Approved February 15, 1888.

STATE OF NEW JERSEY,
Department of State:

I, Henry C. Kelsey, secretary of state of the State of New Jersey, do hereby certify that the foregoing is a true copy of joint resolution No. 3, passed by the legislature of this State and approved by the governor the 15th day of February, A. D. 1888, as taken from and compared with the original now on file in my office.

In testimony whereof I have hereunto set my hand and affixed my official seal, at Trenton, this twenty-seventh day of March, eighteen hundred and eighty-eight.

[SEAL.] HENRY C. KELSEY,
Secretary of State.

RESOLUTION OF THE CITY COUNCIL OF CAMDEN, NEW JERSEY.

The following is an abstract of the minutes of a special meeting of the city council, held February 14, 1888.

Whereas the interest of Camden being identified with that of our sister city Philadelphia, we join in the request for the removal of the islands opposite this city, deeming them an obstruction to navigation and impeding the progress of a great commercial city, causing a formation of a bar at its head which is and has been a continual source of expense to the Government to remove the same, whereby a channel may be opened for the free passage of ferriage, the only means of communication between the two cities; and

Whereas in view of the growing demands of a rapidly increasing population for a more rapid transit, aside from the demands commercially, we urge upon the members of Congress that their influence be extended towards the accomplishment of the request;

Whereas the bill 5978, introduced in the Congress of the United States by the Hon. Samuel J. Randall, to ascertain the relations to commerce of Smith's and Windmill islands in the river Delaware, between Philadelphia and Camden, and to improve the navigation of the Delaware River, embodies the only means whereby the removal of such obstructions can be accomplished: Therefore,

Be it resolved by the city council of Camden, in meeting assembled, That a committee of three members of city council, together with the president thereof, be appointed to appear before the Committee on Rivers and Harbors of the House of Representatives of the United States and urge the passage of House bill No. 5978.

I, D. Cooper Carman, clerk of the city of Camden, do hereby certify that the foregoing is a true copy of the resolution adopted by the city council of the city of Camden.

In witness whereof I hereunto set my hand and cause the corporate seal of the city of Camden to be hereunto affixed this 27th day of March, A. D. 1888.

[SEAL.] D. COOPER CARMAN,
Clerk of the City of Camden.

LETTER OF THE SECRETARY OF THE PHILADELPHIA BOARD OF HARBOR COMMISSIONERS.

OFFICE OF HARBOR COMMISSIONERS,
Philadelphia, March 29, 1888.

SIR: I inclose you herewith a clipping from the Public Ledger of November 30 last, giving an account of a meeting held at the office of the board of port wardens, in conformity with the following newspaper notice which was published in several of our daily papers:

"Notice.

"OFFICE OF THE HARBOR COMMISSIONERS,
"*November* 26, 1887.

"In considering the question of the removal of Smith's and Windmill Islands, the harbor commissioners will hold a meeting at the office of the board of port wardens (Commercial Exchange Building) on Tuesday next, the 29th instant, at 12 o'clock noon. All persons interested in wharves and the further extension of piers on the Delaware River are invited to be present.

"WILLIAM R. TUCKER,
"*Secretary.*"

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In addition to the above notice about seventy-five postal cards were sent out conveying invitations to those known to be interested in the ownership of piers and in the question generally.

Yours truly,

W. R. TUCKER,
Secretary Board of Harbor Commissioners.

Col. WM. P. CRAIGHILL,
Corps of Engineers, Chairman, etc.

[From the Public Ledger, November 30, 1887.]

LOCAL AFFAIRS—HARBOR IMPROVEMENTS—VIEWS OF CITIZENS AS TO THEIR IMMEDIATE NEED—AN IMPORTANT CONFERENCE BETWEEN THE HARBOR COMMISSION, ADVISORY BOARD OF ENGINEERS, AND REPRESENTATIVES OF THE CITY'S COMMERCIAL INTERESTS.

A conference was held in the office of the board of port wardens at the Chamber of Commerce at noon yesterday, between a large number of representatives of the commercial interests of the city on the one hand and the authorities who have under consideration the measures for the improvement of the harbor of Philadelphia. The meeting was called by the harbor commission, in order that the advisory board of Government officials (appointed by the President of the United States) might obtain "the views and wishes of those persons interested in the commercial prosperity" of Philadelphia, the particular project under consideration being that for the removal of Smith's and Windmill islands, and the changes which would be necessary in event of that work being done.

There were present: Capt. George B. White, U. S. N.; Lieut. Col. Henry M. Robert, Engineer Corps, U. S. A.; Prof. Henry Mitchell, U. S. Coast and Geodetic Survey, and H. L. Merendin, secretary, constituting the Advisory Board; Henry Windsor, Edwin A. Gaskill, Charles S. Lewis, Chief Engineer and Surveyor Samuel L. Smedley and Wm. R. Tucker, of the harbor commission; Joel Cook, George A. Cotton, Edw. K. Stevenson, and N. McKinley Wilson, of the board of port wardens; Master Warden Christian K. Ross, Harbor Master Charles Lawrence, president of common council; President George B. Roberts, of the Pennsylvania Railroad; Superintendent Sweigard, of the Philadelphia and Reading Railroad; John H. Weeks, agent of the Baltimore and Ohio Railroad in this city; W. W. Frazier, jr., of Harrison, Frazier, & Co.; Benjamin S. Janney, of Janney & Andrews; Francis and Alfred Cope, John Price Wetherill, F. A. Churchman, president of the Tug-Boat Owners' Association; L. G. Schermerhorn, of the U. S. Engineer Office; Pay Director A. W. Russell, U. S. N.: Spencer C. McCorkle, of the U. S. Coast Survey; Prof. Lewis M. Haupt, University of Pennsylvania; Philip Fitzpatrick, General W. L. James, F. R. Pemberton, president of the Pennsylvania Warehousing and Storage Company; William and Frederick W. Taylor, Charles A. McGinley, Samuel T. McDonnell, W. T. Hager, Hon. Charles O'Neill, William Harkness, J. K. Wheeler, and Edward R. Sharwood.

The meeting was organized by the election of Benjamin S. Janney as chairman and Jonathan Gillingham secretary; after which Mr. Windsor stated the objects of the meeting. He said the Harbor Commission's first work was in connection with the preservation of the harbor. It would be useless to expend money for improvements before the needed steps are taken to prevent injury from the encroachments constantly being made. Heretofore all of the money provided by the National Government has been used to improve the approaches to the harbor, the engineers having charge of the work taking the ground, very properly, that a good harbor would be of no value unless the vessels can get to it. Mr. Windsor then went on to say that the Advisory Board, having now come to the question of the harbor itself, as to how far the city wharves can be extended in order to afford facilities for the vessels now used, and what new changes may be necessary, they want to know what the citizens of Philadelphia desire in the matter before they go on with their consideration of their plans.

OPINIONS OF WHARF-OWNERS.

Philip Fitzpatrick, speaking as a wharf and ship-owner, stated that at the present day very few steamers are built which are under 400 feet, and it ought to be well understood that if Philadelphia wants vessels of large tonnage to come to her harbor her wharves must be at least 500 feet long; yet none of them are over 400, and the majority of them are much less.

George W. Burton, speaking of the proposed extension of the wardens' line, in order to permit of the lengthening of the piers, said the line was now out as far as it

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can go on the immediate city front. To extend the present 250-foot piers would be a very expensive business, and he did not know of any wharf-owners who could do it and expect to get any revenue from their property. The gross income now is very small, and 50 per cent. of it is eaten up in taxation, cost for dredging out material deposited in the docks by the city's sewers (for which the city makes an utterly inadequate appropriation), and in other ways. He thought the removal of the islands would be to take away a barrier against the northeast winds; that if it was not for the islands Delaware avenue would be frequently flooded, and that the wharves would have to be raised 4 or 5 feet, and the "taxation and expense would be something fearful." He thought the jetties built above Smith's Island had resulted in the filling up of the docks; that the Pennsylvania Railroad trains on Delaware avenue were injuring the wharf properties. He asked who would pay the expenses of improvements in which the whole city was to share the benefits. He did not think the wharf-owners ought to bear it all. He also questioned the practicability of the plan.

Mr. Windsor remarked that the possibility of the proposition was not under consideration then. "We are here to find out what the city wanted. The engineers who have studied the question can tell us whether it is feasible."

Colonel Robert said there was no practical difficulty in extending the wharves, though the deep water and rapid current would increase the cost. It was merely a question of dollars and cents.

Mr. Burton thought the cheapest and best way to secure deeper and longer docks was for the city to buy the properties, widen Delaware avenue, and extend the docks to the west.

WHAT THE CITY SHOULD DO.

Joel Cook said that Mr. Burton was a representative of the wharf-owners of Philadelphia, and that what he had said about the difficulties to owners of the short wharves was a subject for serious consideration. Here are one hundred separate wharf-owners, every one of whom has a direct pecuniary interest in the matter; and yet a majority of them can not really afford to make the improvements necessary. If this plan of removing Smith's and Windmill islands and extending the piers is decided to be feasible, then it becomes the duty of the city to give some attention to the matter, and to do something to demonstrate the desire of the city to foster its commerce. Mr. Cook thought that if the Government agreed to pay the expense of clearing the channel, the city's duty was to adopt some broad and comprehensive scheme to take the river front and improve it in accordance with these plans. This was a thing, he said, we have a right to call upon the city to do. He did not think any encouragement could be gotten from Washington unless the city and State give some earnest that they will contribute toward the improvement.

All the diverse interests are looking at the plans from their respective individual stand-points, and he believed that the city would have to get possession of the wharves or she will never have the commerce. Mr. Cook said also that thus far the city authorities had done nothing for the commercial interests at stake, and they want to be awakened to the importance of attending to something else than celebrations. He believed the city would respond if called upon. She has a splendid river, magnificently lighted (mainly through the efforts of Captain White), but that what was lacking was suitable wharfage. He cited the case of the Clyde to show what had been done in the way of stimulating commerce under the most difficult conditions.

Edward K. Stevenson, who was the next speaker, thought there was no force in the objection urged by Mr. Burton to the effect that the islands formed a barrier to the northeast winds, the removal of which would be disastrous. He found that while wharf-owners complained about low profits, it is most difficult to buy any wharf property at any reasonable price. The owners are getting no adequate revenue because the property is not in a condition to earn more.

NEW JERSEY'S ATTITUDE.

Mr. Windsor at this point remarked that injury had been to wharf property in this city because of the attitude of New Jersey. He believed it would be of little use to spend money on improvements unless the harbor can be protected, and he thought it was the imperative duty of councils to apply to the General Government to take charge of the matter, as has been done in cases where two States do not agree upon what shall be done. "Our harbor is in great danger from a power over which we have no control."

John Price Wetherill thought the riparian commissions of New Jersey had done all that could be required of them. They are ready to extend their line 700 feet; and New Jersey, instead of being a laggard, seems likely to be a little ahead of Philadelphia in improving the channel. He thought the unanimous action of the three bodies representing the commercial interests of the city—the Commercial and Maritime Ex-

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changes and the Board of Trade—was sufficient to show that the improvements were wanted. The widening of Delaware avenue would be a proper city expense; and he thought with proper co-operation between the corporate and private interests the improvements could be brought about.

"We improve the property for the benefit of the city at large," said Mr. Burton, "and we lose by it."

Harbor-master Lawrence said the city wanted to be informed as to what her people want, and he claimed that the corporation was never slow in the matter of public improvements. He added that great public improvements for the public good were not stopped because of individual inconveniences.

"I am in favor of extending the wharves," said Mr. Fitzpatrick, "no matter who pays for it. I have had an experience as a ship and wharf owner for over thirty years, and I know the necessity of encouraging commerce. Every vessel which comes here distributes from $500 to $10,000 among the people who most need it, and we can not expect to do a large business unless we show that we appreciate it by providing the proper facilities."

Hyman L. Lipman, speaking "merely as a citizen and as one who had no knowledge of the engineering features of the proposition," expressed the belief that unless efforts are made to bring trade here it will be diverted elsewhere. The great mistake Philadelphia made, he thought, was in giving League Island to the Government. If that is not to be used as a naval station or a gun foundry steps should be taken to get it back, when it could be used greatly to the benefit of the commerce of the port.

PRESIDENT ROBERTS TALKS.

President George B. Roberts, of the Pennsylvania Railroad Company, was then called upon to give his views in the matter, particularly with reference to the attitude of the New Jersey authorities. Mr. Roberts said that, with the engineers of the company, he had looked into the subject and had reached the conclusion that nothing but the removal of Smith's Island would afford the facilities needed, and that that would be of no use unless the New Jersey authorities agreed to extend the riparian line at least half the distance, which, he believed, ought to be done to produce the best effect. The commissioners indicated a willingness to do what the engineers deemed right in reference to moving out the line so as to make the channel clear when the island is removed. "As an engineer," continued Mr. Roberts, "I believe that if this is done the difficulties in reference to the wharves will be largely remedied. Our experience is in the line indicated by the gentleman who has complained of the cost of maintaining them, but the cause is more due to the presence of Windmill Island than anything else. The island makes a deep and narrow channel on this side, and it will have to be removed, and the water, being allowed to distribute more widely, would have a proper depth.

"In this matter it will not do to consider what is the interest of the individual. The Pennsylvania Railroad will have to expend a very large sum, but it will be benefited by it. If we are to bring our ferry up to what the future will require we must have a different Warden's line. If the islands were removed there would then be an opportunity to improve the wharf properties and make them suited to the commerce of the day. That they are not suitable is hardly worth arguing here to-day. Philadelphia gets nominally nothing for her piers, because they are nominally worth nothing. Our duty now is to ascertain what is best for the city, and if any individual does not see fit to improve, his property must remain unproductive, and those who do improve will reap the benefit. It is absolutely necessary that the islands should be removed, and the work is a trifling one in comparison with what it means for this city."

A SUGGESTION FROM PROFESSOR HAUPT.

After Superintendent Sweigard had stated briefly that the Reading Railroad Company would join in the movement, Professor Haupt said he wanted to suggest one or two thoughts which had not been touched upon. He said: "Suppose the changes are made and the great ocean steam-ships can come to the piers along the city front proper to load and discharge. This would necessitate enormous transportation of freight and an engorgement would result. Then perhaps Philadelphia will not always depend upon ferry connection with Camden, and in the event of the construction of a bridge the island would be found to be an advantage." He suggested a division of the commerce, the foreign vessels being received, say, at the mouth of the Schuylkill, while the upper wharves could be used for domestic commerce.

Francis Copo thought that wharf-owners generally would be glad to take advantage of any chance to extend.

Mr. Stevenson read a letter from General Manager McLeod stating that the Reading Company would assist in any movement for the improvement of the port, and would

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extend their pier at Willow street as nearly as possible simultaneously with the removal of the island.

Finally, upon motion of Mr. Winsor, a resolution was passed urging the carrying out of the plan, and Mr. Cook suggested that with a view of furthering the project the meeting had better adjourn, subject to the call of the chair, which was agreed to.

After a few remarks by Congressman O'Neill, in which he expressed his cordial approval of the conclusion reached and promised his hearty co-operation, the meeting adjourned.

LETTER FROM LEONARD MYERS, ATTORNEY FOR WILLIAM LONGSTRETH.

PHILADELPHIA, *March* 28, 1888.

DEAR SIR: By a recent act of Congress you are authorized to report upon the condition of Smith's, Windmill, and other islands and shoals or bars in the river Delaware opposite to Philadelphia, which it is proposed to remove in the interest of commerce, and also the probable cost of such removal.

To the north and east of Smith's Island, and separated from it by a narrow channel only, is an island of 10 acres and 91 perches, which, upon survey, was granted by the State of Pennsylvania to Joseph Fox and Moses Preston by patent dated December 30, 1831.

This patent and the mesne conveyances by which the title vested in the present owner, William Longstreth, are recorded in the office of the recorder of deeds of Philadelphia County, and the taxes upon said island have been regularly paid.

The Engineer's Department of the Army has for the past eight years been endeavoring to dredge and keep open a channel through Mr. Longstreth's island, treating it as a bar (and calling it Smith's Island Bar), because, as they state, it is *slightly* below mean low water. It is well known, however, that this has not always been the case, and your yearly official report shows that the constant accretions and filling up have caused considerable expense to keep the channel open. In fact, a comparatively small expenditure would fill up Mr. Longstreth's island and make it very valuable.

He has always deemed the channel to be in the interest of commerce, but very properly the War Department was notified of his rights to the island, now owned in his family for thirty-five years.

So careful of these rights has the State of Pennsylvania been that many years ago when it was proposed to cut a channel through this island an act of the legislature granting the authority provided that "the consent of the owners be first obtained."

Mr. Longstreth believes that the removal of these islands in the Delaware will be of great benefit to our national commerce.

Congress having inquired the probable cost of such removal, he authorizes you to report that he will accept from the Government for his said property and all loss of its removal the sum of $5,000.

I am, very respectfully, yours,

LEONARD MYERS,
Attorney for William Longstreth.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers,
President Board of Engineers, U. S. A.

G 2.

IMPROVEMENT OF FRANKFORD CREEK, PENNSYLVANIA.

No work was done on Frankford Creek during the last fiscal year, and no appropriation for its improvement has been made since that of August 2, 1882, appropriating $10,000. This amount was practically expended during the fiscal year ending June 30, 1883, in the formation of a dredged channel 7 feet deep at mean low water, and extending from the mouth of the creek to above Bridge Street Bridge, Bridesburgh.

This creek is entirely within the corporate limits of Philadelphia, and it is understood to be regulated by the municipal authorities. It

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is not considered in the interest of commerce and navigation to recommend further appropriations.

Frankford Creek lies wholly within the port of entry of Philadelphia, at which the revenue collected during the year ending December 31, 1887, amounted to $17,878,424.46. The nearest fort and light-houses are, respectively, Fort Mifflin and Horseshoe Range Lights.

Total appropriations to June 30, 1888	$10,000.00
Total expenditures to June 30, 1888	9,735.50

Money statement.

July 1, 1887, amount available	$264.50
July 1, 1888, balance available	264.50
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1887.

Class.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Sailing vessels	110	10,500	110	10,500
Barges	25	5,000	25	5,000
Total	135	15,500	135	15,500

Imports.

Articles.		Quantity.	Value.
Wood	cords	1,000	$4,250.00
Coal	tons	5,000	15,000.00
Lumber	feet	2,500,000	20,000.00
Sand	tons	3,000	4,500.00
Soda-ash	do	1,000	30,000.00
Hay	do	500	2,500.00
Total			76,250.00

The above information was furnished by the Mason Fruit Jar Company, of Bridesburg.

G 3.

IMPROVEMENT OF SCHUYLKILL RIVER, PENNSYLVANIA.

No operations have been in progress during the past fiscal year since the appropriation of $18,750, approved August 5, 1886, was practically exhausted, in the year ending June 30, 1887.

The present project proposes the formation of a channel 400 feet wide and 24 feet deep at mean low water from the mouth of the river to Girard Point, a distance of about 1 mile; from thence to Gibson's Point, a further distance of about 3 miles, a channel 20 feet deep, and 200 feet wide; from thence to Chestnut Street Bridge, Philadelphia, a distance of about 3 miles, a channel of navigable width and 18 feet deep at mean low water. This latter reach of river has required no other improvement than the

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removal of about 1,000 cubic yards of rock near Locust and South streets. The channels proposed are to be obtained by dredging, at an estimated cost of $485,000, of which amount $368,750 has been appropriated.

The present demands of commerce limit the requirement of an improved condition of river channel to that part of the river lying between the mouth and Gibson's Point, or the lower 4 miles of the river. At Girard Point are located large grain elevators and wharves. At Gibson's Point and Point Breeze, which are near each other and closely related as to commercial requirements, are the large storage tanks and shipping wharves of the petroleum oil refineries. The large interests assembled at these three points cover mainly the commerce of the Schuylkill River, and both the grain and oil trade require deep-draft vessels for the proper and economical transaction of their business. Channel depths should exist which would permit the passage of vessels at all stages of the tide between the mouth of the river and Gibson's Point drawing 24 feet of water. As it now is, deep-draft vessels are permitted to move only at high water, or else are obliged to lighter part of their cargoes.

The work which has been applied to the river between the mouth and Gibson's Point has resulted in producing a channel from 150 to 200 feet wide and 20 feet deep at mean low water. Between Gibson's Point and Girard Point the deepened channel has been permanent, but between Girard Point and deep water in the Delaware River the maintenance of the dredged channel has not been satisfactory.

As previously stated the project proposes a depth of 24 feet at mean low water between Girard Point and the Delaware River. Between 1875 and 1878 this part of the river was deepened to 24 feet by the removal of 242,000 cubic yards of material; in 1880 it had shoaled to about 20 feet. Between 1881 and 1884 it was again deepened to 24 feet by the removal of 266,000 cubic yards of material; in 1887 a survey was made of this part of the river and it was found that the channel had again shoaled to 20 feet. To redredge the channel to a depth of 24 feet for a width of 300 feet would require the removal of about 250,000 cubic yards of material, or about the quantity which has been twice removed since 1875.

The shoaling principally occurs over a portion of the channel about 1,500 feet in length and situated directly at the river mouth. The shoaling is mainly due to the abrupt angle at which the tidal currents of the Schuylkill meet those of the Delaware River, and also to the abnormal width of the former river at this point. From the experience of the past it seems highly probably that, instead of attempting to maintain the desired depth of 24 feet in this part of the river by dredging, it would be more assuredly and economically accomplished by the aid of a dike so placed as to produce tidal concentration upon the shoal area.

The work which has been done is of great benefit to commerce, and the further improvement of the river would be of great advantage. If funds become available for continuing the improvement of the river a project will be submitted covering the improvement of the bar at the river's mouth by means of a dike in connection with dredging.

An appropriation of $75,000 is recommended for the fiscal year ending June 30, 1890, and if an appropriation is made it will be applied in furtherance of the approved project.

This work lies in the collection district of Philadelphia, at which, as a port of entry, there was collected during the year ending December 31, 1887, revenue to the

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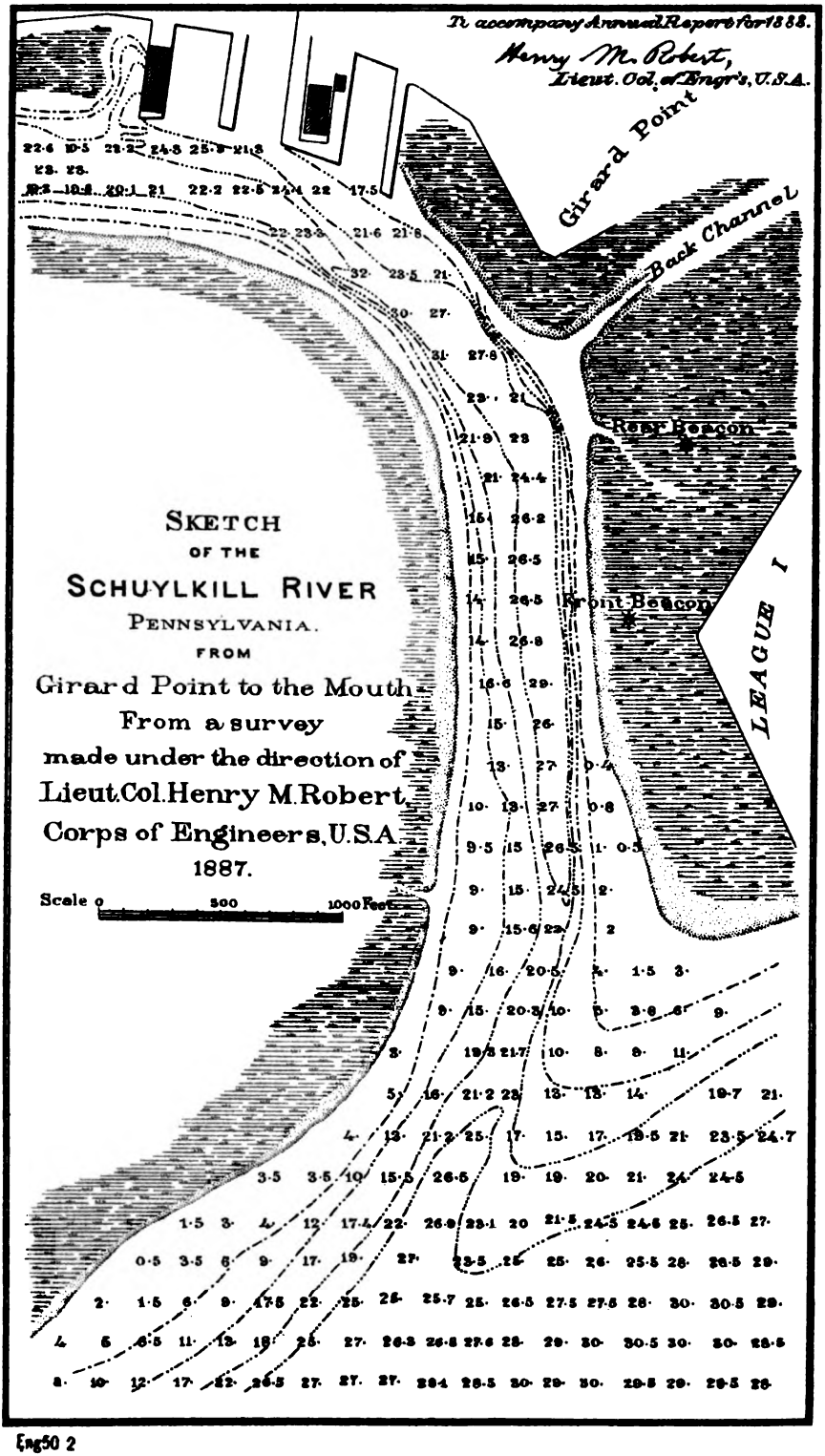

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amount of $17,878,424.46. The nearest fort and light-houses are, respectively, Fort Mifflin and Schuylkill River range-lights.

Total appropriations to June 30, 1888	$368,750.00
Total expenditures to June 30, 1888	368,519.13

Money statement.

July 1, 1887, amount available	434.87
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	204.00
July 1, 1888, balance available	230.87
Amount appropriated by act of August 11, 1888	25,000.00
Amount available for fiscal year ending June 30, 1889	25,230.87
Amount (estimated) required for completion of existing project	91,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1887.

Steamers (not including tugs)	83
Sailing vessels	501
Barges	260
Total	844

Freight statement.

Received:		
Iron ore	tons	1,022
Barrels (empty)		887,341
Miscellaneous merchandise	tons	25,978
Shipped:		
Grain	bushels	4,967,497
Flour	barrels	45,000
Petroleum (crude and refined)	do	1,233,237
Do	cases	4,809,960
Do	gallons	6,707,935
Miscellaneous merchandise	tons	13,975

The above information was furnished by five different firms most largely interested in the improvement of the Schuylkill River.

G 4.

IMPROVEMENT OF ICE-HARBOR AT MARCUS HOOK, PENNSYLVANIA.

The river and harbor act approved August 5, 1886, appropriated $15,000 for improving ice-harbor at Marcus Hook, Pa. Under date of August 17, 1886, a project was submitted and approved August 25, wherein it was proposed to apply so much of this appropriation as might be necessary to removing the stone superstructure of Pier No. 6, and rebuilding it at the lower end of the harbor on the line of Pier No. 7 and the shore pier upon a timber crib foundation. The stone superstructure of Pier No. 6 was built in 1881 upon a pile foundation and had given evidences of weakness by settling towards the channel of the

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river. Pier No. 5, the companion to No. 6, careened in 1882, shortly after its completion, and was subsequently rebuilt on a crib foundation.

Under date of March 24, 1887, a contract was made with Mr. Ira Lunt for the construction and placing of the timber crib foundation at the point before named, and for removing the stone superstructure from Pier No. 6 and replacing it upon the new foundation.

During the past fiscal year the proposed new pier has been completed and the pile foundation of Pier No. 6 removed, two groups of mooring piles placed between existing piers, and the available deep-water area of the harbor increased to 10 acres by dredging 58,000 cubic yards from the previous shoal area at the lower end of the harbor.

At the close of the fiscal year ending June 30, 1887, the construction of the timber crib which was to form the substructure for the new pier was in progress. Under the above named contract with Mr. Ira Lunt the crib foundation has been completed, sunk in position, and the superstructure removed from Pier No. 6 and placed upon the crib foundation thus prepared for it.

Influenced by borings on file in the office, which indicated hard bottom suitable for the crib foundation at the proposed site of the new pier at a depth of 25 feet below mean low water, the timber crib foundation was built 25½ feet high. Before placing the crib additional borings developed the fact that the character of the bottom at the site of the proposed pier was such as to require the foundation to be carried to a depth of 30 feet below mean low water before a substratum was reached which was sufficiently unyielding to bear the weight which would be imposed upon it by the proposed pier. To accomplish this the trench to receive the crib foundation was excavated to a depth of 30 feet below mean low water and then filled to a height of 25 feet below mean low water with random stone carefully leveled to receive the timber crib substructure.

The stone required to form this foundation amounted to 559 cubic yards, and being outside of the contract with Mr. Ira Lunt for the construction of the pier, was furnished by Messrs. Lieper & Lewis under informal proposals at the rate of $1.08 per cubic yard.

The entire cost of the pier, including the additional foundation, was $8,289.79. The cost for a similar pier built two years previous was $15,600.

The low price at which the contract was made for building the pier left a balance available for further work of about $5,400 from the $15,000 on hand. Under date of August 10, 1887, a modified project for the expenditure of this balance of $5,400 was submitted to the Chief of Engineers, recommending its application for the removal of the piles which formed the previous foundation for Pier No. 6, the placing of two groups of mooring piles between the inner row of ice-piers, and the dredging of about 60,000 cubic yards of material from the shoal area at the lower end of the ice-harbor. This recommendation was approved August 17, 1887, and under an agreement with the American Dredging Company, derived from informal proposals, the pile foundation of Pier No. 6 was removed for $200, two groups of mooring piles were placed for $200, and 58,000 cubic yards of material dredged at the rate of 7¾ cents per cubic yard.

This dredging increased the area of that part of the ice-harbor which is under the protection of the piers from 6 to 10 acres. The depth at low water which now covers this area is from 20 to 24 feet.

As previously stated, Piers Nos. 5 and 6 were originally built in 1881 upon a pile foundation. Pier No. 5 careened in 1882, and was subse-

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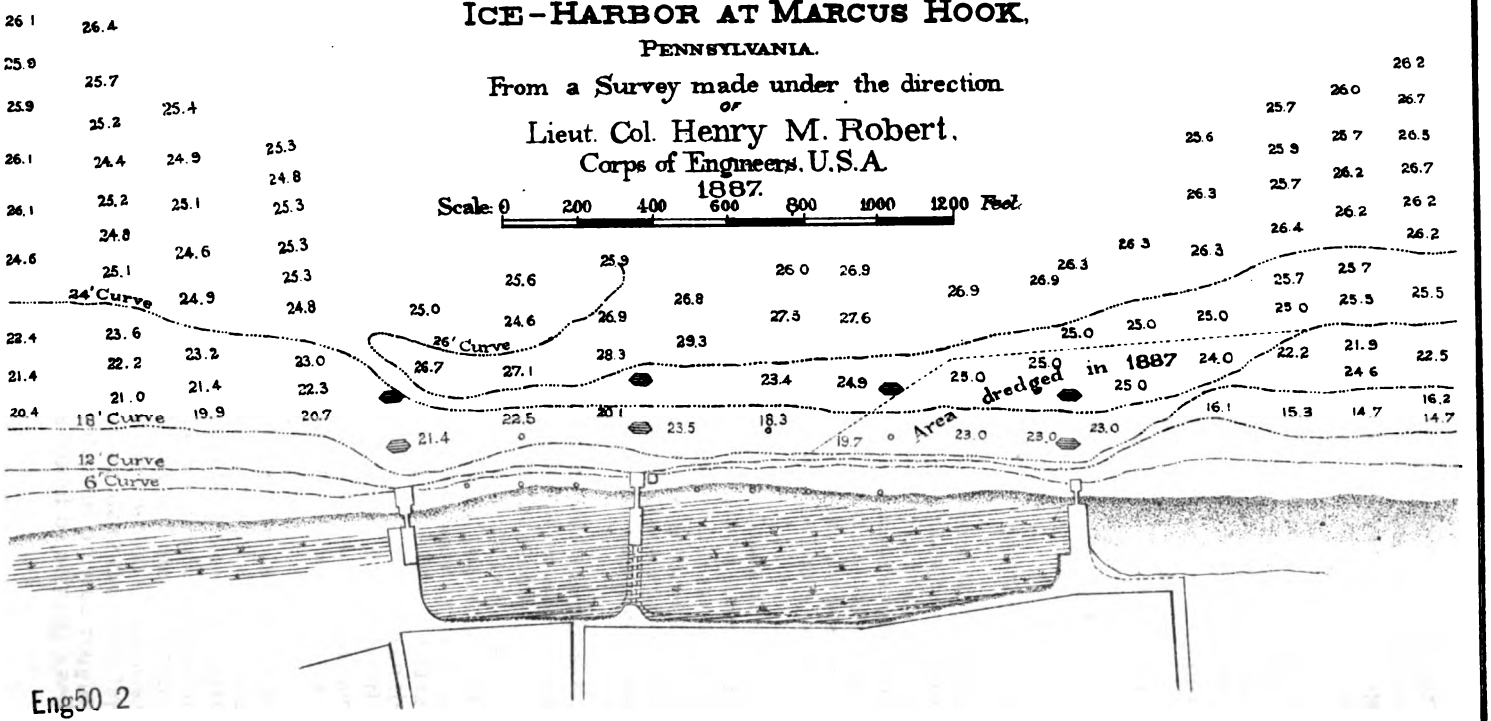
To accompany Annual Report for 1888.

Henry M. Robert
Lieut. Col. of Engr's. U.S.A.

SKETCH
OF
ICE-HARBOR AT MARCUS HOOK,
PENNSYLVANIA.

From a Survey made under the direction
OF
Lieut. Col. Henry M. Robert,
Corps of Engineers, U.S.A.
1887.



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quently rebuilt on a crib foundation. Pier No. 6 had also given evidences of the instability of its foundation, which threatened it with the fate of No. 5. To avert such disaster the stone superstructure was removed and placed upon a crib foundation at the lower end of the harbor.

The specifications under which the two piers were built in 1881 required the piles forming the foundations to be driven to a depth of 36 feet below mean low water; at this depth hard bottom would have been reached. In removing the piles from the foundation of No. 6 it was found that they had only been driven to a depth of from 29½ to 31½ feet below mean low water, or from 6½ to 4½ feet less than the depth required by the specifications and the character of the bottom. The piles were driven therefore into a very soft clay without passing through it and reaching a hard bottom, and the fair inference is that the principal cause for the failure of the foundations of Piers Nos. 5 and 6 was the improper character of the work done by the contractor. The contract for this work was with the Mount Waldo Granite Company, and the work was done for that company by Ira Lunt.

The harbor is of considerable value to the commerce of the river during the winter season. Its utility will continue even when the proposed ice-harbor at the head of Delaware Bay is built, since the ice-harbor at Marcus Hook will always be valuable as a refuge for vessels in the upper part of the river. The value of the harbor to vessels seeking temporary refuge from ice is somewhat reduced from the practice of vessel owners utilizing the harbor as a place in which their vessels are permanently placed during the winter season.

In 1880 and 1881 the project for the improvement of this harbor was amended by providing for the construction of a bulkhead about 1,800 feet in length parallel with the shore-line and about 150 feet outside of high-water line, together with the deepening by dredging of the area in front of the bulkhead to a depth of 15 feet at the present low-water line, and decreasing to 10 feet depth alongside of the bulkhead. (See Report Chief of Engineers, 1882, pages 751–755.)

In subsequent action towards carrying into effect this amendment of the project an obstacle arose from the unwillingness of certain riparian owners to voluntarily authorize the construction of the bulkhead along their property frontage. This difficulty has not yet been removed, and even if it could be it is doubtful whether in the light of past experience the advantages of the bulkhead would not be neutralized by its being largely used by vessel owners as a place of safety and free wharfage for their vessels during the winter season of disuse. This has been the practice of the past at the landing piers, and while it enables the owners of such vessels to escape dock and wharf charges, it encumbers the harbor unnecessarily. Against such improper use of a harbor there seems to be no present protective legislation or authority.

It is highly probable that the area directly in front of the bulkhead, lying as it does under the lee of the landing piers, would rapidly shoal from the deposition of river sediment, and would therefore require frequent dredging in order to maintain the proposed depths along the bulkhead. The present harbor has a protected area of about 10 acres, carrying a depth of from 18 to 24 feet at mean low water. This area, with a slight addition to be obtained by dredging along the inner line of the harbor, will be fairly commensurate with the present requirements of commerce, and is probably as large as would be actually available to commerce if the bulkhead were built.

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For the foregoing reasons I would recommend that the hitherto proposed increase of harbor area and facilities by the construction of the bulkhead, and the subsequent dredging of the area immediately in front thereof, be abandoned for the present, and that such funds as may become available be applied to the full development of the present harbor.

The two landing or shore piers built by the United States in 1867–'68 are in immediate need of rebuilding above the water-line on account of the decay of their timber superstructures, and both the substructure and superstructure of the oldest ice-piers require repair. The extension of the deep-water areas of the harbor should also be accomplished by additional dredging.

The work accomplished during the past fiscal year exhausted available funds.

An appropriation of $30,000 is recommended for the fiscal year ending June 30, 1890, to be expended in repairs and dredging.

This work is located in the collection district of Philadelphia. This is the nearest port of entry, the collections during the year ending December 31, 1887, amounting to $17,878,424.46. The nearest fort and light-house are, respectively, Fort Mifflin and Christiana Light.

Total appropriations from 1866 to June 30, 1888	$194,000.00
Total expenditures from 1866 to June 30, 1888	193,919.29

Money statement.

July 1, 1887, amount available	$6,586.54	
July 1, 1887, covered by existing contracts	7,621.60	
		$14,208.14
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		14,127.43
July 1, 1888, balance available		80.71
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,080.71
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

G 5.

ICE-HARBOR AT HEAD OF DELAWARE BAY, DELAWARE.

The act of August 2, 1882, contained an appropriation of $25,000 for "ice-harbor at head of Delaware Bay, and for removal of sunken piers in channel back of Reedy Island, Delaware." The sum of $3,700 was expended in 1883, in removing the sunken piers at Reedy Island, and $5,023.07 has since been expended in surveys, examinations, and office expenses.

The importance of this ice-harbor has been fully set forth in previous reports, but the difficulties connected with it are so great that I do not think there has yet been any satisfactory solution proposed. From all the information I have obtained, the inclosing of the area by a barrier that will prevent the ingress and egress of ice will be no improvement upon the plan of detached ice-breakers as heretofore used in this river. But the question of the most economical construction for the ice-break-

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ers, whether they should be stone piers, pile piers, or floating pontons, requires more study than has yet been given to the subject.

Total appropriations to June 30, 1888	$25,000.00
Total expenditures to June 30, 1888	8,723.07

Money statement.

July 1, 1887, amount available	$17,493.30
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,216.37
July 1, 1888, balance available	16,276.93

G 6.

CONSTRUCTION OF IRON PIER IN DELAWARE BAY, NEAR LEWES, DELAWARE.

No work has been done during the past fiscal year. The last appropriation made was that of $13,000 on August 2, 1882, which was expended between that date and the close of the fiscal year ending June 30, 1884, in repairs to the wooden superstructure of the pier.

The design of the pier provided for a substructure of wrought-iron screw-piles surmounted with a timber superstructure or platform.

The decay of the timber superstructure is very rapid, and to make the pier of value the superstructure must be maintained with unimpaired strength. Parts weakened by decay must be removed early in their deterioration and be replaced by sound material. This renders the life of the timber of short duration, and consequently the cost of maintenance large. To add to the quantity of perishable material in a wooden superstructure would be only to increase largely the cost of its maintenance.

By the act of July 15, 1870, the railroad having its terminus in the vicinity of the pier was granted the privilege "to extend their railroad upon and over said pier and to freely use said pier in connection with their said road, subject to such regulations and charges for maintenance and repairs as the Secretary of War may adopt." The railroad company have not yet exercised this privilege. The present wooden superstructure was designed several years ago before the adoption of the present heavier weights of engines and rolling stock. These increased weights render the present plan of wooden superstructure entirely too light for the increased loads which would be brought upon the pier in its use by the railroad company. On account of the perishable character and inadequate strength of the timber superstructure there seems to be a call for a modification of the hitherto proposed plan so as to adjust it to the demands of modern railroad construction. In accordance with the requirements of the Senate resolution of March 12, 1886, a special report was submitted by the officer in charge, under date of April 2, 1886 (see Report of the Chief of Engineers for 1886, pages 837–839), providing for a modification in the hitherto proposed timber superstructure.

The plan as therein described proposes an iron superstructure with paved surfaces outside of the areas occupied by the railroad tracks upon the pier-head, and an iron superstructure carrying the track upon the approach to the pier-head, combined with the use of timber for the

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deck-covering over that part of the area of the approach not occupied by the railroad tracks. Such an iron superstructure, with a strength fully equal to the requirements of railroad traffic, could be built for about $93,000, and maintained at a trifling cost for repairs, rendering available the permanent iron superstructure, which has been built at a cost of over $300,000.

A wooden superstructure, giving the same strength when new as the proposed iron superstructure, would cost at first probably $40,000, and would practically have to be entirely removed each ten years, so that its aggregate cost would in the end exceed that of an iron superstructure. Even with the above expenditure for repairs the wooden superstructure would frequently be in a condition of impaired strength.

The pier at present is used as a landing place by those who desire to communicate with the shore from vessels entering Delaware Breakwater Harbor; by the Light-house Establishment for the temporary storing of material, and by the Quarantine service in connection with the marine hospital located at Cape Henlopen.

During the gale of March 12, 1888, twenty-seven vessels were wrecked in Delaware Breakwater Harbor, and at that time the schooner *E. V. Mason*, becoming unmanageable, was blown against the north side of the pier near its shore end. Five of the wrought-iron screw-piles of the outer row were injured by the collision to the extent of two being broken and the other three bent over. The lateral bracing of these piles was also displaced, and with it the timber superstructure covering the half width of the pier at the place of injury for about 125 linear feet of the pier. A passage-way about 10 feet wide connects the uninjured parts of the pier.

To properly repair the pier the five injured piles and their connecting brace-rods will require to be removed; the two broken piles will have to be repaired or replaced by new ones, as may be deemed best after their removal, and the three bent piles straightened, after which the piles can be replaced in their original positions and the superstructure restored. The timber required to repair the superstructure could be obtained from material on hand. The cost of restoring the injured part of the pier to its original condition would probably reach $6,000, which is required at once.

If the project for an iron superstructure, previously referred to, should be approved, an appropriation of the entire amount estimated, namely, $93,000, is recommended for the fiscal year ending June 30, 1890, as when the change of superstructure is begun the pier will be useless until the new superstructure is completed. This is in addition to the $6,000 required for repairs.

The pier is in the collection district of Delaware, the nearest port of entry being Wilmington, where the amount of revenue collected during the year ending December 31, 1887, was $2,053.06. The nearest fort and light-house are, respectively, Fort Delaware and the Delaware Breakwater light.

Total appropriations to June 30, 1888	$368,500.00
Total expenditures to June 30, 1888	368,375.06

Money statement.

July 1, 1887, amount available	$124.94
July 1, 1888, balance available	124.94

Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	15,000.00

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G 7.

IMPROVEMENT OF HARBOR AT DELAWARE BREAKWATER, DELAWARE.

No operations have been in progress during the past fiscal year, available funds from the appropriation of $56,250 by act approved August 5, 1886, having been practically exhausted at the close of the fiscal year ending June 30, 1887.

The work which has been in progress since the adoption of the existing project in 1882 has had for its object the closing of the gap between the breakwater and the ice-breaker by the deposition of the random stone which is to form the substructure of the work. It was estimated in the project upon which the present work is based, that the net volume of the random stone foundation would be about 87,500 cubic yards. From the experience gained in the construction of the breakwater and ice-breaker it is found that each cubic yard of those structures represents 1½ gross tons of random stone. From this data the 87,500 cubic yards of foundation would require about 131,000 gross tons of stone.

There have been 60,762 tons of stone already placed in the gap, leaving about 70,000 tons yet to be placed to supply the volume of the original estimate, provided no allowance is made for the mattresses used in the foundation.

At the prices which have been paid under the three contracts in force since the work of closing the gap was commenced in 1885, and allowing for superintendence, the cost of completing the foundation would be about $175,000. This work could be accomplished in two seasons if the funds therefor were available.

The completion of the foundation would be followed by the construction of the concrete superstructure, which was estimated at about $370,000, including the necessary plant. From this it will be seen that it will probably require more than the $418,750 estimated in the money statement to complete the work. But it is better to postpone a revision of the estimate until after the commencement of the concrete superstructure, or at least until the foundation is about completed.

The importance of this work to both the commerce of the Delaware River and the Atlantic coast is such as to justify sufficient appropriations to complete the breakwater by closing the gap at the earliest date possible.

The Maritime Exchange of Philadelphia has established a station on the breakwater and through telegraph-cables connecting the mainland with their stations are in connection with the shipping of the harbor. The reports of the Maritime Exchange state that during the year 1887, 5,751 vessels, exclusive of tugs, fishing, and small coasting craft, anchored under the protection of the breakwater.

On March 12, 1888, the harbor was visited by a gale of almost unprecedented violence, whereby 27 vessels lying in the harbor were wrecked; most of the vessels were driven ashore, and so far as known none of the wrecks have become obstructions or dangerous to navigation. The breakwater sustained no injury from the gale.

During the present season, should funds become available, it is proposed to continue the work of closing the gap between the breakwater and ice-breaker by continuing the placing of stone in the substructure of the work.

An appropriation of $300,000 is recommended for the fiscal year end-

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ing June 30, 1890, and if an appropriation is made it will be applied in furtherance of the approved project for closing the gap.

This work is situated in the collection district of Delaware. Wilmington is the nearest port of entry, at which the revenue collected during the year ending December 31, 1887, was $2,053.06. Fort Delaware is the nearest fort, and the Breakwater Light the nearest light-house.

Total appropriations to June 30, 1888	$2,448,353.70
Total expenditures to June 30, 1888	2,447,823.61
Total appropriations under present project to June 30, 1888	256,250.00
Total expenditures under present project to June 30, 1888	255,719.91

Money statement.

July 1, 1887, amount available	$2,685.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	2,155.88
July 1, 1888, balance available	530.09
Amount appropriated by act of August 11, 1888	100,000.00
Amount available for fiscal year ending June 30, 1889	100,530.09
Amount (estimated) required for completion of existing project	318,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Statement showing number of vessels calling at the Breakwater during the year ending December 31, 1887.

Class.	For orders.	For harbor.	In distress.	Total.
Steamers	16	71	4	91
Ships	12	33	2	47
Barks	86	250	5	341
Brigs	34	79	3	116
Schooners	41	5,079	36	5,156
Total	189	5,512	50	5,751

The above information was furnished by the Philadelphia Maritime Exchange.

G 8.

IMPROVEMENT OF RANCOCAS RIVER, NEW JERSEY.

During the past fiscal year no work has been done on this river. The last appropriation ($10,000) was made August 2, 1882, and available funds were practically exhausted during the fiscal year ending June 30, 1883.

The Rancocas River enters the Delaware at a point opposite Torresdale, or about 12 miles above the foot of Market street, in the port of Philadelphia.

The act of March 3, 1879, provided for a survey of the river from its confluence with the Delaware to Pemberton, N. J.

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In 1881 the project was adopted for the formation by dredging of a channel from 150 to 200 feet wide and 6 feet deep at mean low water from the mouth to Centreton, a distance of 7¼ miles, and from thence a channel 5 feet deep to Mount Holly, 5¾ miles above Centreton. The estimated cost of the work was $82,000.

By act of March 3, 1881, $10,000 was appropriated for the work. During the fiscal year 1881–'82 this amount was applied to the formation of a channel 85 feet wide and 6½ feet deep through the worst obstruction on the lower river, known as Coates' Bar, which is about 4 miles above the river's mouth. The work was accomplished by dredging and the formation of a dike parallel with the channel and extending from the north bank and the upper end of Hamill's Island.

By act of August 2, 1882, $10,000 was appropriated to continue the improvement. During the fiscal year 1882–'83 this amount was expended in widening to 150 feet the channel through Coates' Bar.

No operations are contemplated during the present season, as no funds are available.

In furtherance of the approved project, a channel with a low-water depth of 6 feet should be dredged through the shoals between Coates' Bar and Centreton at a cost which has been estimated at $22,000. This amount could be profitably expended during the fiscal year ending June 30, 1890.

Rancocas River is in the collection district of Trenton, N. J., which is the nearest port of entry, at which no revenue was collected during the year ending December 31, 1887. The nearest fort is Fort Mifflin, and the Horseshoe Lights are the nearest lighthouses.

Total appropriations to June 30, 1888	$20,000.00
Total expenditures to June 30, 1888	19,899.91

Money statement.

July 1, 1887, amount available	$100.09
July 1, 1888, balance available	100.09
Amount (estimated) required for completion of existing project	62,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	22,000.00

Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers (not including tugs)	385	52,400	385	62,000
Sailing vessels	1,490	73,000	1,490	91,600
Barges	610	80,000	610	124,000
Canal-boats	1,450	78,000	1,450	94,000
Total	3,935	283,400	3,935	371,600

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Freight statement.

Articles.	Quantity.	Value.
RECEIVED.		
Lumber.....feet..	2,800,000	$52,000
Timber.....do...	700,000	7,000
Coal.....tons..	10,200	40,800
Machinery.....	.....	10,000
Lime.....bushels..	120,000	19,600
Saltpeter, potash, etc.....tons..	500	20,000
Brimstone.....do...	860	17,200
Manure.....cart-loads..	12,000	10,800
Miscellaneous merchandise.....	.....	120,000
Total.....	.....	297,400
SHIPPED.		
Sand (molding).....tons..	154,000	462,000
Fertilizers.....do...	8,500	250,000
Fruit.....baskets..	28,000	12,000
Vegetables.....do...	50,000	25,000
Canned goods.....pounds..	1,800,000	45,000
Total.....	.....	794,000

The above information was furnished by Messrs. J. J. Allen's Sons, of Philadelphia, Pa.

G 9.

IMPROVEMENT OF WOODBURY CREEK, NEW JERSEY.

No work of improvement has yet been done on this creek. The only appropriation made therefor was $5,000, on August 2, 1882. With the exception of $450.31 expended in 1882 for a survey of the creek, this amount is yet available.

Woodbury Creek discharges into the Delaware River about 8 miles below Philadelphia, at a point opposite Fort Mifflin. Its confluence forms the southern boundary of the Government reservation for site of defenses at Red Bank, N. J.

The plan of improvement based upon the survey of 1882 proposed the formation, by dredging, of a temporary channel, 8 feet deep at high water and 40 feet wide, between the mouth of the creek and the village of Woodbury, a distance of about 4 miles, at an estimated cost of $15,000. From the impossibility of the permanence of a dredged channel the improvement would be of little value unless provision is made for its maintenance. While citizens directly interested have expressed themselves as willing to contribute a reasonable sum towards the maintenance of the channel, there is no guaranty that a channel once formed by the United States would be maintained by private effort. Since the formation of a dredged channel to any point short of Woodbury would be of no commercial value, and since any channel formed would not be permanent, the expenditure of available funds should be withheld, if the improvement is to be made, until the funds available will permit the formation of the proposed channel in a single season. The additional sum of $10,500 could be profitably expended during the fiscal year ending June 30, 1890.

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This work is in the collection district of Philadelphia, Pa., which is also the nearest port of entry, at which the revenue collected during the year ending December 31, 1887, was $17,878,424.46.

Fort Mifflin is the nearest fort, and the Schuylkill range-lights are the nearest light-houses.

Total appropriations to June 30, 1888	$5,000.00
Total expenditures to June 30, 1888	450.31

COMMERCIAL STATISTICS.

No statistics could be obtained from parties interested in this improvement.

Money statement.

July 1, 1887, amount available	$4,549.69
July 1, 1888, balance available	4,549.69
Amount (estimated) required for completion of existing project	10,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

G 10.

IMPROVEMENT OF MANTUA CREEK, NEW JERSEY.

No work of improvement has yet been done on this creek. The only appropriation made therefor was $3,000, on August 2, 1882, the expenditure of which was withheld, by order of the Secretary of War in 1883, until further appropriations should be made.

Mantua Creek discharges into the Delaware River about 10 miles below Philadelphia at a point abreast of Mifflin Bar. The stream in its natural condition has a low-water depth of about 9 feet for a distance of between 5 and 4 miles from its mouth. Above this the channel depth slowly decreases until at Mantua, about 11 miles above the mouth, there is a low-water depth of only 2 feet. The opinion of officers previously in charge was that there seems to be no necessity at present for further appropriations, and none are recommended.

This work is in the collection district of Philadelphia, Pa., which is also the nearest port of entry, at which the revenue collected during the year ending December 31, 1887, was $17,878,424.46.

Fort Mifflin is the nearest fort, and Tinicum and Fort Mifflin Bar range-lights are the nearest light-houses.

Total appropriations to June 30, 1888	$3,000

COMMERCIAL STATISTICS.

No statistics could be obtained from parties interested in this improvement.

Money statement.

July 1, 1887, amount available	$3,000.00
July 1, 1888, balance available	3,000.00
Amount (estimated) required for completion of existing project	32,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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G 11.

IMPROVEMENT OF RACCOON RIVER, NEW JERSEY.

No work of improvement has yet been done on this river. The only appropriation made therefor was $3,000, on August 2, 1882. With the exception of a part expended in 1882 upon a survey of the river this amount is yet available.

The Raccoon River discharges into the Delaware about 20 miles below Philadelphia, at a point opposite Marcus Hook Harbor.

The proposed plan of improvement, based upon the survey of 1882, proposes to make by dredging the navigation of the river safer and less difficult up to Swedesborough, at an estimated cost of about $18,000. By previous recommendation the appropriation of 1882 was withheld from expenditure until additional appropriations are made.

If the improvement is to be made, the sum of $16,000, in addition to what has already been appropriated, could be expended in dredging during the fiscal year ending June 30, 1890.

This work is in the collection district of Philadelphia, Pa., at which the revenue collected during the year ending December 31, 1887, was $17,878,424.46.

Fort Mifflin is the nearest fort, and the Tinicum Island and Fort Mifflin Bar range-lights the nearest light-houses.

Total appropriations to June 30, 1888	$3,000.00
Total expenditures to June 30, 1888	757.23

COMMERCIAL STATISTICS.

Mr. John Ford and Mr. J. L. Clark, of Swedesborough, N. J., report that there has been no material change in the commerce of Raccoon River since the last statistics furnished by them and published in my last annual report. (Report of Chief of Engineers, 1887, page 811.)

Money statement.

July 1, 1887, amount available	$2,242.77
July 1, 1888, balance available	2,242.77
Amount (estimated) required for completion of existing project	16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	16,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

G 12.

IMPROVEMENT OF SALEM RIVER, NEW JERSEY.

No work has been done on Salem River during the past fiscal year.

Salem River discharges into the Delaware River by its natural mouth at a point about 4 miles below Fort Delaware. At a point in the Delaware River about 10 miles above the natural mouth of the Salem River a canal was constructed by private enterprise, which connects with the Salem River at the point of its nearest approach to the Delaware. Just below the junction of this canal with Salem River a dam has been built across the latter stream which essentially divides the river into two parts, viz, from the natural mouth to the dam, and from the mouth of the canal to the headwaters of the river.

Under the act of July 11, 1870, a survey of the mouth of Salem River was ordered, which developed the existence of an obstruction consist-

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ing of loose rock and gravel and bowlders embedded in tenacious clay, which reduced the depth of water to about 6 feet at mean low water.

The appropriation of March 3, 1871, of $4,000 was applied in 1871 to the formation of a channel through this obstruction 200 feet wide and 9 feet deep at mean low water.

The next appropriation was that made by act of June 18, 1878, of $3,000 for continuing the work at the mouth of the river. The act also provided for the survey of the river between Sharptown and the canal.

On October 14, 1878, a contract was entered into with M. F. Brainard for dredging, at the rate of 22 cents per cubic yard, a channel 8 feet deep at mean low water and to as great a width as the funds would permit. After removing 1,400 cubic yards the contract was annulled, on account of the small progress made and the unsatisfactory character of the plant.

During the fiscal year 1879–'80, the balance on hand of the appropriation of 1878 was applied in removing 6,034 cubic yards and the consequent formation of a channel from 65 to 70 feet wide and 8 feet deep through that part of the bar where previous dredging had been in progress.

On June 14, 1880, $3,000 was appropriated for continuing the improvement at the mouth, and applied in 1880–'81 to widening to 110 feet the channel previously dredged.

On March 3, 1881, $3,000 was appropriated for the improvement of the river above the inner end of the canal, and during the fiscal year 1881–'82 this amount was expended in dredging a channel from 6 to 7 feet deep at low water and 60 feet wide from the head of the canal to a point near Biddle's Landing.

On August 2, 1882, $1,500 was appropriated for continuing the improvement, but the smallness of the amount to be expended rendered the proposals for dredging excessive, and, further work being postponed, the appropriation of August 2, 1882, has remained on hand since that date.

At the point where the creek most nearly approached the Delaware River, in the vicinity of Deep Water Point, a canal was opened in 1872, for the better drainage of the meadows bordering the upper part of the creek and to secure a more direct water outlet for the products of that region. In furtherance of this design a dam was also built across the creek below the canal, thus separating the stream into two independent water-courses, one having its head at the dam and discharging past Salem into the cove, the other with its head of navigation at Course's Landing, 3 miles below Sharptown and 9 miles from the Delaware, into which it discharges via the canal, which forms the lower 2 miles of its length. The mouths of the two streams are now, therefore, about 10 miles apart, and the drainage of each is entirely distinct.

The canal has, to a great extent, failed to accomplish its purpose by reason of its originally insufficient capacity, whereby the tidal rise, which is about 6 feet in the Delaware, is reduced to about 1 foot at the confluence of the canal and creek.

The natural mouth of the stream is obstructed by extensive sand-bars, to which dredging has afforded but temporary relief, and would continue to do so unless supplemented by quite expensive dike construction, extending across these shoals and into the Delaware River, while the bed of the upper part of the river is obstructed with shoals, or reduced, from lack of tidal flow, to the dimensions of a meadow brook.

It would seem that the comprehensive improvement of the Salem River might be deferred until the commerce of the vicinity should ren-

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der its improvement more urgent than it seems to be at present. Should Congress consider it desirable to continue the improvement, the deepened channel on the upper river might be completed to Hoxie's Bridge, which has been estimated to cost $4,000.

Salem River is in the collection district of Bridgeton, N. J., which is the nearest port of entry, at which the revenue collected during the year ending December 31, 1887, was $196.28. The nearest fort and light-houses are, respectively, Fort Delaware and Finn's Point range-lights.

Total appropriations to June 30, 1888	$14,500.00
Total expenditures to June 30, 1888	13,009.34

Money statement.

July 1, 1887, amount available	$1,490.66
July 1, 1888, balance available	1,490.66

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers (not including tugs)	280	21,000	280	21,000
Sailing vessels	140	5,600	140	5,600
Barges	50	4,000	50	4,000
Total	470	30,600	470	30,600

Freight statement.

Articles.	Quantity.	Value.
RECEIVED.		
Coal ..... tons..	500	$20,000
Lime ..... bushels..	20,000	2,000
Manure ..... cart loads..	35,000	24,500
Total		46,500
SHIPPED.		
Grain ..... bushels..	60,000	35,000
Apples ..... baskets..	10,000	3,000
Watermelons ..... number..	400,000	32,000
Sweet-potatoes ..... baskets..	200,000	80,000
White potatoes ..... bushels..	10,000	5,000
Total		155,000

The above information was furnished by Mr. E. E. Kiger, of Sharptown, N. J.

G 13.

IMPROVEMENT OF COHANSEY CREEK, NEW JERSEY.

No work has been done on Cohansey Creek during the past fiscal year, and no appropriation for its improvement has been made since that of August 2, 1882, appropriating $5,000.

Cohansey Creek discharges into the Delaware River at a point about 22 miles below Fort Delaware, or nearly opposite Bombay Hook Point.

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The act of June 10, 1872, provided for a survey of the creek. Based upon the survey a project was adopted which provided for the formation of a dredged channel at Bridgeton 130 feet wide and 4 feet deep at low water from the lower steam-boat landing to Broad street, and thence a 3-foot channel to the Nail Works Bridge. The estimated cost of the work was $30,000.

In 1879 the project was modified by reducing the width of the channel to 80 feet and increasing the depth to 7 feet between the steam-boat landing and Broad Street Bridge; above that point the channel to be 5 feet deep. In 1880 the project was further modified by extending the proposed 7-foot channel to Commerce Street Bridge and the 6-foot channel to the Nail Works Bridge, increasing the estimated cost to $41,000. Of this amount $36,000 has been appropriated.

By act of March 3, 1873, $10,000 was appropriated for the work, which was expended in 1873–'74 in dredging a channel 80 feet wide and 3 feet deep at low water along the city wharves and for a distance of one-half mile below Broad Street Bridge.

The act of June 18, 1878, appropriated $5,000 and that of March 3, 1879, $4,500 for continuing the work. These amounts were expended during the fiscal year 1879–'80 in dredging, which extended the 7-foot channel 65 feet wide to Broad Street Bridge and thence 45 feet wide to Commerce Street Bridge, except at the former, where the city gas and water pipes reduced the available depth to between 3 and 4 feet.

The act of June 14, 1880, appropriated $4,500 and that of March 3, 1881, $7,000. In 1880–'81 the channel below Broad Street Bridge was widened to 80 feet, and between Commerce Street Bridge and the Nail Works Bridge a shoal was deepened to 4 feet at low water. On this work about $4,500 was expended.

In 1881–'82 operations were suspended pending the action of the city of Bridgeton in relation to lowering the gas and water pipes at the Broad street crossing.

The act of August 2, 1882, appropriated $5,000.

During the fiscal year 1882–'83 the available balance, about $12,000, from the appropriations of 1881 and 1882, was expended in widening the channel below Broad Street Bridge to a uniform width of 90 feet between the upper and lower steam-boat wharves. No appropriations have been made since 1882.

The attention of the city authorities has been officially called in the past to the obstructing gas and water pipes at Broad Street Bridge, and they have had the question of lowering these pipes under consideration for several years, but no action thereon has yet been taken. The improvement of the creek above this point would be without value until the pipes are lowered to a proper depth by the municipal authorities of Bridgeton, and until this is done no appropriation is recommended.

This work is in the collection district of Bridgeton, N. J., which is the nearest port of entry, at which the revenue collected during the year ending December 31, 1887, was $196.28.

The nearest fort and light-house are, respectively, Fort Delaware and Maurice River Light.

Total amount appropriated to June 30, 1888	$36,000
Total amount expended to June 30, 1888	36,000

COMMERCIAL STATISTICS.

No statistics could be obtained from parties interested in this improvement.

Money statement.

Amount (estimated) required for completion of existing project	$5,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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G 14.

REMOVAL OF WRECKS FROM DELAWARE BAY AND RIVER.

During the past fiscal year but one wreck has been removed under the above appropriation.*

In February, 1886, the schooner *David Lee* was sunk about 1¾ miles from Fourteen-Foot Bank Light, in Delaware Bay. The vessel having been abandoned by its owners and being considered a danger to navigation, the required notice to owners was published and proposals invited for the removal of the wreck.

Under date of December 13, 1887, a contract was entered into with Charles W. Johnston for its removal for the sum of $1,000. The work was accomplished April 27, 1888.

Money statement.

July 1, 1887, amount available	$2,290.60
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,531.98
July 1, 1888, balance available	758.62

Abstract of proposals for removal of the wreck of the schooner David Lee, lying off Fourteen-Foot Bank Light, Delaware Bay, opened November 18, 1887, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price.
1	F. C. Maull, Lewes, Del	$1,749
2	Edward T. Veasey and Thomas Poynter, Lewes, Del	2,375
3	American Dredging Company, Philadelphia, Pa.	4,309

All bids rejected, being considered too high.

G 15.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

During the past fiscal year two wrecks have been removed under the authority of the act of Congress approved June 14, 1880.

In December, 1887, the schooner *G. H. Bent* was sunk in Delaware Breakwater Harbor, near the western end of the ice-breaker. Under date of March 8, 1888, a contract was entered into with Joseph D. Truxton for the removal of the wreck for the sum of $794. The work was accomplished April 27, 1888.

In February, 1888, the steamer *Blanche Henderson* was sunk in the Delaware River, near the foot of Lombard Street, in the port of Philadelphia. Under date of April 17, 1888, a contract was entered into with John F. Baxter, for the sum of $3,750, to remove the wreck from its site by means of sling-chains and pontoons, and after pumping out

*See also "Removing sunken vessels or craft obstructing or endangering navigation."

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the vessel and temporarily repairing the leaks to deliver it to the United States afloat near Fort Mifflin.

The wreck was removed from its site on May 7, and on May 20 was taken afloat, without the aid of pontoons, to a designated point behind the Government dike between Hog and Maiden islands.

On May 31, in accordance with previous advertisement, the vessel and all property therein contained was sold by the Government to the highest bidder, John Schrader, of Philadelphia, for the sum of $570, which amount was turned into the Treasury of the United States.

Abstract of proposals for removal of the wreck of the schooner G. H. Bent, lying in Delaware Breakwater Harbor, opened March 5, 1888, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price.
1	Elihu J. Morris and Charles W. Johnston, Lewes, Del	$824
2	Joseph D. Truxton, Lewes, Del	794

Contract (dated March 8, 1888) awarded to Joseph D. Truxton.

Abstract of proposals for removal of the wreck of the steamer Blanche Henderson, lying in the Delaware River at Philadelphia, Pa., opened April 12, 1888, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price.
1	Elihu J. Morris and Charles W. Johnston, Lewes, Del	$5,949
2	John F. Baxter, New York, N. Y	3,750
*3	William S. Mason & Co., Philadelphia, Pa	3,000

*Informal.

Contract (dated April 17, 1888) awarded to John F. Baxter.

G 16.

SURVEY OF HARBOR AT ATLANTIC CITY, NEW JERSEY.

The river and harbor act approved August 5, 1886, contained an appropriation of $5,000 for a survey, by a Board of three United States Engineers, of the harbor at Atlantic City, N. J., with a view to making a harbor of refuge at that point.

By Special Orders No. 141, Headquarters Corps of Engineers, September 25, 1886, a Board consisting of Lieut. Cols. Cyrus B. Comstock, Henry M. Robert, and Walter McFarland was appointed to make the survey and examination.

The report of the Board was submitted under date of May 31, 1887, and is to be found in the Report of the Chief of Engineers for 1887, pages 815–819.

During the fiscal year the maps and data of the survey and report were assembled and placed on the office files.

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Money statement.

July 1, 1887, amount available	$2,798.32
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	1,217.93
July 1, 1888, balance available	1,580.39

G 17.

UNITED STATES COMMISSION ADVISORY TO THE BOARD OF HARBOR COMMISSIONERS OF PHILADELPHIA, PENNSYLVANIA.

During the fiscal year ending June 30, 1888, the personnel of the United States Commission Advisory to the Board of Harbor Commissioners of the Port of Philadelphia has remained unchanged. It is constituted as follows:

Capt. G. B. White, United States Navy, chairman; Prof. Henry Mitchell, United States Coast Survey, and Lieut. Col. Henry M. Robert, United States Engineer Corps, members, and Mr. H. L. Marindin, United States Coast Survey, secretary.

The port warden's line from Bridesburgh to the upper limits of the city, on the Delaware front, as fixed by this commission, has been adopted by the harbor commission and approved by the city councils.

Port warden's lines have now been established around the entire water-front of the city, except from the mouth of the Schuylkill south, and around Smith's and Windmill islands. This does not include the New Jersey side of the harbor, which is not under the control of the city of Philadelphia.

The harbor commission having requested this commission to report upon the problem of the removal of Smith's and Windmill islands, and the adjacent shoals, for the purpose of extending the wharves on the Pennsylvania side of the river, this commission made a careful study of the subject and submitted its conclusions in the report hereto annexed.

The subject of establishing lines around Smith's and Windmill islands will not be considered until the question as to their removal is decided.

It is important that the turning points of the port warden's line on the Delaware River should be referred to fixed points on shore, and this commission has called the attention of the harbor commission thereto.

THE ADVISORY COMMISSION'S REPORT.

PHILADELPHIA, *December* 16, 1887.

To the Board of Harbor Commissioners of the City of Philadelphia:

GENTLEMEN: The Advisory Commission to the Board of Harbor Commissioners of Philadelphia has carefully studied the problem submitted to it in the following resolution adopted by your commission:

Resolved, That the advisory council of the harbor commissioners be requested to examine and report concerning the physical relations of Smith's and Windmill islands, and the shoals adjacent thereto, to the improvement of the harbor,

and respectfully report as follows:

At our request, Prof. Henry Mitchell, United States Coast and Geo-

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detic Survey, a member of this Board, prepared a paper on the physical relations of Smith's and Windmill islands to the Delaware River. It is attached hereunto and made a part of this report. Col. Henry M. Robert, United States Corps of Engineers, in charge of the improvement of the Delaware River, and a member of this Board, at its request, prepared a diagram showing the movements of the shoals in front of the city of Philadelphia, with a paper discussing these changes, and a design for a harbor between Camden and Philadelphia which would permit the extension of the wharves on the Philadelphia front between Washington avenue and Willow street. This paper, with inclosures, are hereunto attached, and form part of this report.

The statement of principles and of facts as set forth in the papers referred to were adopted by this Board as its views on the subject.

A meeting of the citizens of Philadelphia was held at the port wardens' office on November 29, when this commission carefully listened to statements made for and against the proposed removal of Smith's and Windmill islands and the adjacent shoals, for the purpose of extending the wharves in front of the city of Philadelphia.

We have carefully studied the subject by an examination of the surveys, charts, and diagrams kindly furnished us by the United States Coast and Geodetic Survey and the United States Engineer Corps. After a full discussion of all the data before us, this commission has reached the following conclusions, viz:

(1) Assuming that the commercial prosperity of Philadelphia demands an extension of the wharves on the Delaware front of that city, between Washington avenue and Willow street, such reasonable extension can be made, without injury to the harbor, by the skillful execution of a properly prepared project.

(2) No such extension should be made without the removal of Smith's and Windmill islands and the shoals above and below them.

(3) That the ebb current should be deflected as much as possible away from the Pennsylvania shore towards the middle of the stream, to relieve the pressure on the pier-heads.

(4) The removal of the islands and shoals without any auxiliary works will not to any extent relieve this pressure.

(5) That the proper place to change the direction of the ebb current to the course desired is at and in the vicinity of Petty's Island.

(6) Any project for the extension of the wharves and the removal of the islands and shoals should be comprehensive enough to include the improvement of the harbor from the head of Petty's Island to the lower end of the shoals, and also the control of the wharf-lines on both sides of the river.

We desire to call attention to the discussion of the movement of the shoals in front of the city referred to by Colonel Robert.

This commission, in 1883, advised the cutting away of part of Petty's Island nearly identical with that proposed in the design for a harbor. It was then the opinion of the commission that the place to stop the movement of the shoal above Smith's Island towards the Philadelphia shore was at Petty's Island, by inducing the greater volume of water to pass down the Pennsylvania channel, around that island.

The conclusion reached by Colonel Robert, that the change of the crest of the shoal off Race-street Wharf 250 feet back from the Pennsylvania shore since the construction of the dike at Fisher's Point, seems to be a practical demonstration of the soundness of the theory then advanced.

An important point is demonstrated by the plotting of the present

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wharf lines of the chart of 1843, which shows that since that date wharves have been extended 250 feet; at and above Arch street the line of deepest water was crossed, and at Arch street the wharves were extended in 57 feet of water.

The design presented by Colonel Robert contemplates carrying out the port-wardens' line about 300 feet beyond the present line, and provides an unobstructed water-way between Camden and Philadelphia 2,000 feet wide, with the west half of this width carrying at least 26 feet at low water, and the east half gradually decreasing from this depth to not less than 12 feet on the New Jersey shore.

The amount of material to be removed, including the work at Petty's Island, will be about 10,000,000 cubic yards, and the cost of such removal should not exceed $2,000,000, which does not include the cost of Smith's and Windmill islands and the part to be cut away from Petty's Island.

The wording of the resolution of your commission, under which we are acting, might not seem to have called for the comprehensive study that we have made, but the views expressed at the citizens' meeting and the action of various maritime bodies in the city have given to the inquiry more latitude perhaps than had been anticipated.

Very respectfully, your obedient servants,

G. B. WHITE,
Captain U. S. Navy, Chairman.
HENRY MITCHELL,
U. S. Coast and Geodetic Survey.
HENRY M. ROBERT,
Lieut. Col. of Engineers, U. S. Army.

HENRY L. MARINDIN,
Coast and Geodetic Survey, Secretary.

PROFESSOR MITCHELL'S REPORT.

THE PHYSICAL RELATIONS OF SMITH'S AND WINDMILL ISLANDS TO DELAWARE RIVER.

When the advisory commission was first appointed by order of President Hayes, in 1880, it learned with much concern that the harbor commissioners, whom it was to advise, had no jurisdiction beyond the water front of Philadelphia; that counsel was required in the location of restrictive port-warden lines upon one bank of the river without any control over structures upon the opposite shore.

In this anomalous position the advisory commission shrank from a task so obviously beyond its abilities, and on the 16th of December, 1880, passed the following resolution unanimously:

"*Resolved*, That in the opinion of this commission the proper adjustment of the port-warden lines upon the Pennsylvania side of the Delaware River is impracticable without an equal consideration of those upon the New Jersey side."

To this resolution the commission adhered until May, 1883, when it received an official plotting of the harbor lines adopted on the New Jersey shore, and a vote from the harbor commission requesting that a scheme of harbor lines be prepared for the city front.

After much discussion the commission agreed to accept the harbor lines adopted by New Jersey as accomplished facts in the case, and voted to proceed to the location of lines as desired.

In November, 1884, the commission, through its chairman, reported a system of port-warden lines covering the city front, from League Island to Bridesburg, in which no change was recommended between Dickinson and Ann streets. This excluded portion was believed to have been advanced already as far as could safely be admitted—the pier-heads being at some points within 200 feet of the thread of the ebb current and the deepest water of the channel, so that any considerable advance might involve no less an act than turning the Delaware.

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It should be remarked here that a physical survey of the harbor, from League Island to Five-Mile Point, had been made and published before the advisory commission was created.* From this data any one could ascertain the depth, velocity, and volume to be turned by any proposed wharf extension, and the commission based the scheme of lines which it recommended largely upon this strictly physical data.

The question of the removal of Windmill and Smith's islands has been very much discussed, not only by the aid of the physical survey just mentioned, but with further examinations of the neighborhood, and we believe that nothing but good can be expected from taking out these obstructions, if the work is done without spilling. That there may be a tendency to deposit again must certainly be admitted, but the Delaware is not a heavily loaded stream at any time, and the banks of sand that travel down along its bed are limited, so that the running expense of keeping the harbor free will be small.

The advantages to commerce from the removal of these obstructions to navigation, anchorage, winding-room, and transit are too obvious to need more than the mention; but the popular belief that this removal will greatly relieve the pressure of the ebb current along the city front and make an advance of the wharves in this part of the city easy and of useful effect is not warranted by our studies.

Regarding this neighborhood our secretary, Mr. Henry L. Marindin, in a report dated March 30, 1885, makes the following statement: "From cross-sections 4 to 9 we have the comparison of both the Windmill Island channels. We may continue to notice the advance of the wharf-line more marked, however, between the years 1843 and 1878. This advance has in most cases been followed by an increase of channel depth, which is an improvement only where the depth is insufficient; but here the depth exceeds the wants of commerce, so that a questionable improvement was obtained at the expense of width of water-way where navigable room was already restricted. The depth along the island front has remained without change. In the eastern channel the marked advance of the Jersey shore, by its occupation by wharves, has also been followed by increase of channel depth."†

But while the scour induced by the advance of wharves on the Philadelphia side has been mostly executed very near the ends of the wharves, the deepening in the eastern channel, consequent upon the advance of structures from the Camden shore has been more general across the whole water-way or disposed to abrade the island shore.

We see, then, that no favorable change in the channel (already 50 or 60 feet deep) along the western shore has been effected by the advance of wharves; and the current turned off from this shore does not seem disposed to wear upon the shore of Windmill Island, although the channel is scarcely more than 1,000 feet wide. From which we might properly argue that the digging away of Windmill Island would not relieve the pressure upon the opposite wharves of Philadelphia. Moreover, the advancement of the wharves of Philadelphia in this neighborhood would touch the very body and life of the river, since it would reach the deepest water and the swiftest flow.

From our observation of 1878 and 1879, it appears that at that time each foot of advance from the occupied frontage on the Philadelphia shore involved the displacement of sixteen times the volume of water at the strength of the ebb that a similar advance from the New Jersey wharves would have done, or five times as much as an equal advance beyond the Camden port warden's line of that date. Since that date, however, the port wardens' line on the Camden shore has been moved out, it is said, 300 feet, so that from this new position (without assuming any increase of velocity), each foot would have only 40 per cent. of the value here that it has on the Philadelphia shore.

In assuming that the removal of Windmill Island might offset in part the extension from the New Jersey shore, we have reflected our experience in such studies. It appears that uniform extension from the convex side does not cause a race along the front as happens on the concave side—as one might have very well argued from considering the direction of the particles and the angle of impact. But we may expect that the advance of the Camden shore will augment the pressure along the Philadelphia front somewhat.

Windmill and Smith's islands belong to that class of dry shoals known upon our western rivers as tow-heads. They lie sometimes at the points of inflection between reverse bends and sometimes on the slackwater side of the bend itself. In this latter case the channel on the convex side of the river is a sort of waste-way or cut-off.

In the Delaware the presence of a flood current alternating with the ebb in the dry season complicates the formation a little; but, on the whole, we may conclude that Windmill Island does not yet resist any will of the river, however changed

* Appendix 9, Ann. Rep. Coast and Geodetic Survey, 1878.
† Appendix No. 12, Ann. Report Coast Survey, 1885.

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from its natural disposition. If the river had been given a tendency to leave the bend as the wharves were advanced this tow-head would have melted away.

[Colonel Robert in his subsequent paper has shown that the shoal above yielded as the wharves were advanced.]

Of course the Delaware became the site of a great city because of its natural facilities for commerce, its deep channels, bold shores, etc., and these must be preserved as far as possible even where not utilized. But the wants of commerce may come to exceed the natural resources, and necessitate some artificial control of the river, in which case it would be well to thwart as little as possible the natural order, because it involves a running expense. It not only requires a great outlay to acquire the control, but a perpetual tax to hold it.

Any act so serious as turning a river, however slightly, involves excavations and deposits elsewhere that no one can foresee; and, although many of the distant consequences may not be evil, all that does go wrong will be charged to the same account.

It must be borne in mind that the harbor of Philadelphia is the pathway of a river and the drain-way of great tidal basins, and the extreme demand of river flood and rare tides must be provided for. Nature, however, always leaves a margin for artificial improvement.

To look for a moment at one of the strictly economic aspects of the question, let us inquire whether the harbor of Philadelphia can spare the water space. If we take the two miles reach from Cooper's Point to Old Navy-Yard, containing Smith and Windmill islands as central features, we find that the average width of clear waterway in 1883 outside of lines connecting ends of wharves was 2,460 feet—the Smith Island section being little short of 2,000 feet open water and the Windmill Island section about 2,300 feet. With these islands removed the width would have been in this neighborhood 2,700 feet, or 240 feet more than the average. If, however we measure between the port-warden lines of Philadelphia and Camden shores, we find that in 1883 the width, with the islands removed, would have been 2,600 feet; since which it is said that the Camden line has been moved out 300 feet, reducing the width to 2,300 feet, or 160 feet below the average.

It is proper to count superficial width, because the time will probably come when shoals will be removed; and 2,300 feet is little enough for any harbor, especially as all the commerce for eleven miles of city frontage above this must make this a thoroughfare. One foresees the pack of vessels that may some day stop the way in this place and prevent the development of excellent frontage further up the river.

Nevertheless 2,300 feet of an unobstructed channel-way, everywhere of ample depth, is much more than the harbor now enjoys—more perhaps in effect than it had in 1819, when the water spaces on the two sides of Windmill Island summed up over 3,000 feet.

HENRY MITCHELL,
U. S. Coast and Geodetic Survey.

DECEMBER 10, 1887.

COLONEL ROBERT'S REPORT.

A study of the problem, "How can the wharves on the Delaware front of the central part of Philadelphia be extended without serious injury to the river?"

The wharves in the locality referred to have been already extended far beyond the original shore-line, this extension being so great as to cross the line of the deepest water at Arch and Race streets. The existing Port Wardens' line is about 250 feet in advance of the head of the pier at Arch street in 1843, and from 150 to 200 feet in advance of the piers at the same date at Vine, Race, Market, and Chestnut streets. This extension of the wharves, which was made between the surveys of 1843 and 1878, did not produce a corresponding cutting from the islands and bars in the middle of the river, although off Race and Arch streets, where the piers crossed the deepest water-line, one-half the reduction of width was compensated for by a cutting away of 100 feet from Smith's Island Shoal. Since 1878 the portion of this shoal between Vine and Arch streets has been practically stationary below the 20-foot curve, while above that depth it moved to the west between 1878 and 1883, the crest of the shoal moving in that time about 300 feet.

At Callowhill street the extension of the wharves was much less, and did not come near to the deepest water-line, so that apparently the only effect was a deepening of the channel just beyond the pier line. But the upper end of the bar was approaching the Philadelphia shore, the movement of the crest of the bar in this direction being about 600 feet at Callowhill street between 1843 and 1878, while between 1878 and 1883 the crest remained stationary and the body of the bar moved westerly, the 18-foot curve, for instance, moving 250 feet towards Philadelphia in the five years.

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Since 1883 we have two surveys of Smith's Island Bar, one made by the United States Coast and Geodetic Survey in 1896, and the other by the United States Engineer Department in November, 1887. These surveys show no change in the shoal between these latter dates, but they show a remarkable change since the survey of 1883, the crest of the shoal having swung to the east a distance of 450 to 500 feet at Callowhill and Vine streets, and 250 feet at Race street, practically placing it where it was in 1843. [The piers across the shoal just above Smith's Island, and the gravel deposited just above them for their protection, have prevented any change opposite Arch street.]

This shifting of the shoal westerly between 1843 and 1883, and then easterly between 1883 and 1887, seems to be accounted for by the two facts (1) that between the first dates, when the shoal shifted westerly, the channel between Philadelphia and the lower end of Petty's Island was greatly contracted by the extension of piers on both sides of the river, and the reduction of the width between 1843 and 1878 being about 470 feet at low water and about 800 feet at high water; and (2) that between the latter dates, 1883 and 1887, when the shoal shifted easterly, a dike 3,000 feet long had been built from Fisher's Point towards the head of Petty's Island, thus increasing the flow of water through the channel between Philadelphia and Petty's Island, and partially counteracting the bad effects of the contraction of the Philadelphia channel at the foot of Petty's Island. It should be noticed that while the narrowest part of this channel is 1,120 feet wide at low water, the shortest distance between the legal harbor-lines bounding this channel is only 1,000 feet, so that at any time it may be farther contracted to the injury of the harbor.

The depth of water on the upper part of Smith's Island Shoal was from 6 to 8 feet greater in 1843 than in 1878, when the channel at the lower end of Petty's Island had been so contracted. Since the construction of Fisher's Point Dike the bar has lowered to within 2 feet of its depth in 1843.

A study of the various surveys of this harbor made by the United States Coast and Geodetic Survey in 1843, 1878, and 1886, and by the United States Engineer Department in 1883 and 1887, of which some of the results have been just stated, lead to the opinion that no serious injury to the river would result from the extension of the wharves on the Delaware front of the central part of Philadelphia, provided the harbor-lines are made to conform approximately to those laid down in the sketch herewith. This plan involves—

(1) The widening of the channel between Philadelphia and the lower half of Petty's Island to a least width of about 1,700 feet, with such an increase of width at the lower end as is required to adapt it to the lines on the New Jersey shore, as shown on the sketch.

(2) The removal of Smith's and Windmill islands, and the shoals above and below to a suitable depth.

(3) The extension of the wharves on the Philadelphia front, from about Hanover street to about Washington avenue, approximately, as follows: Starting at Hanover street, on the present Port Wardens' line, the proposed Port Wardens' line would be advanced 175 feet at Shackamaxon street and 300 feet at Green street, continuing at about that distance in advance of the present line to Lombard street, whence the advance would diminish until the two lines would coincide near Washington avenue.

(4) The modification of the exterior wharf line on the New Jersey shore, as established by the riparian commissioners, so as to keep it about 2,000 feet distant from the proposed Philadelphia Port Wardens' line until near Cooper's Point, where it should hug the shore, so as not to divert the current from the New Jersey shore.

(5) A slight modification of the adopted wharf-lines at the lower end of the channel to the south of Petty's Island, so as to make these proposed lines approximately parallel to the present deepest water-line near the mouth of this channel.

The dredging of about 10,000,000 cubic yards of material (scow measurement) would remove the islands and shoals, including a portion of Petty's Island, so as to give a harbor 2,000 feet wide below Petty's Island, the western half of which would have a least depth of 26 feet at mean low water, and the eastern half a depth gradually lessening from 26 feet in the middle of the river to at least 12 feet at the shore. It would at the same time allow of the advance of about 2 miles of the Port Wardens' line in the center of the city, permitting the construction of docks about 500 feet in length, without increasing the currents, so as to cause any material engineering difficulties in their construction and maintenance.

Since the preparation of this paper and accompanying sketch of a modified harbor for the port of Philadelphia I find that practically all the modifications proposed on the New Jersey shore at Cooper's Point and Petty's Island have been approved in the past by the Advisory Commission.

Accompanying this paper are the following:

(1) * Sketch of the harbor of Philadelphia on the Delaware River, so modified as to render feasible the advance of the Port Wardens' line 300 feet in the center of the city front.

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(2) * Cross-sections of Smith's Island Bar and the Philadelphia Channel in 1843, 1878, 1883, 1886, and 1887.
(3) * Chart of the Philadelphia Harbor from the survey of 1843, showing the encroachments on the river since that date.

HENRY M. ROBERT,
Lieut. Col. of Engineers, U. S. A.

U. S. ENGINEER OFFICE,
Philadelphia, Pa., December 11, 1887.

G 18.

PRELIMINARY EXAMINATION OF THE THOROUGHFARE RUNNING BACK OF THE OCEAN FROM CAPE MAY TO THE GREAT BAY NORTH OF ATLANTIC CITY, NEW JERSEY.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., December 24, 1886.

SIR: In compliance with instructions contained in your letter of October 28, 1886, I have the honor to submit the following report on a preliminary examination of the Thoroughfare running back of the ocean from Cape May to the Great Bay, north of Atlantic City, N. J.:

This Thoroughfare is about 63 miles long and consists of some ten bays or sounds, and of connecting channels varying in width from 100 to 1,000 feet.

I made a personal examination of the route from Ludlam's Bay to Peck's Bay, including the intermediate thoroughfares and Corson's Sound, and the entire route from Cape May to Great Bay was gone over by Assistant Engineer L. Y. Schermerhorn between November 1 and 6, under the guidance of Capt. George H. Dare, an old resident and experienced navigator of these waters. Soundings were occasionally made, and the shallow reaches connecting the deep water were located at the time on the maps of the State geological survey. The examination was based upon the idea of getting a channel 6 feet deep at mean low water, as, from all I could learn, this depth would meet all the demands of commerce for several years. In fact, whatever may be the future development of this region, the first thing to do is to open the entire route to a depth of not over 6 feet, and if appropriations were small it might be better to limit the depth to even 4 feet at first.

The distance from Cape May to Great Bay in an air-line is about 47 miles, while by the best channel through the bays and thoroughfares back of the ocean beach it is about 63 miles. Of this 63 miles, about 53 miles have a least depth of 6 feet at mean low water, while the remaining 10 miles appear to have less than 1 foot, portions being entirely out of water. This distance of 10 miles, divided into eight shoals or divides, must be considered as requiring an excavation 6 feet deep to insure a 6-foot channel. The channel should have a mean width of 75 feet, so that the excavation can be roughly estimated at upwards of 1,000,000 cubic yards, scow measurement. An accurate survey might increase this estimate.

Judging from ten years' experience with running dredges owned by the United States, and having built two, I believe that $100,000 will cover the cost of building suitable plant and excavating and removing the 1,000,000 yards of material estimated as required by the above plan, but I doubt the safety of an estimate for doing this work by contract based on anything lower than 25 cents a cubic yard, or $250,000 for the entire improvement. The plant would have to come from the vicinity

* Omitted.

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of New York or Philadelphia, and would not, probably, be specially adapted to such shallow work. Contractors would, probably, hesitate to build plant suitable for such work, because there would be great risk in building the plant before they were awarded a contract, and then it would be too late.

Furthermore, it might not pay to build special plant for only one season's contract, and they would not be sure of any more.

This question of how such a shallow channel is to be excavated in a region where there is no similar work being done, so that special plant should be constructed for the purpose, is a very serious one, affecting the cost of the work, I think, as much as 100 per cent.

At present the commerce through this thoroughfare consists mainly of oysters and garden produce, the latter having for a market the neighboring sea-side resorts, principally Atlantic City.

The vessels used are small sail-boats whose draught does not exceed 2 feet, and they can not cross the divides at low water. A 6-foot channel 75 feet wide would allow small steamers to be placed on the route, which doubtless would greatly increase the commerce seeking this route, and especially would it be used by pleasure steamers during the summer. The oyster trade would probably be greatly developed.

The question as to whether this route is worthy of improvement is rendered difficult of solution by the doubt overhanging the question of its cost. It seems to me that the benefits to be derived from the improvement to the extent of a 6-foot channel 75 feet wide would justify the expenditure of $100,000, but I am not prepared at present to say that they would justify the expenditure of $250,000. In other words, with my present knowledge of the subject, I am of opinion that the improvement is worthy to be made if it can be done for $100,000, but that it is not worthy to be made if its cost amounts to $250,000.

I would estimate the cost of a survey of the route, including a project with estimate of cost of the improvement, at not less than $2,000.

There are forwarded herewith the following documents:

1. A tracing showing the location of the proposed improvements.
2. Assistant Engineer L. Y. Schermerhorn's report of his examination of the route (without the maps).
3. A communication from C. K. Landis, esq., founder of Sea Isle City, showing the importance of the proposed improvement.
4. Copy of a letter from Isaac A. Braddock, esq., on the same subject.

So far I have been unable to get any commercial statistics; should any be received they will be forwarded.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., December 7, 1886.

SIR: I have the honor to submit the following report on the examination made between November 1 and 6, 1886, of the "Thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J.," required by the act of Congress approved August 5, 1886.

The examination was made by passing over the route in a sail-boat under the guidance of Capt. George H. Dare, an experienced pilot long resident in the vicinity and thoroughly familiar with the best water to be obtained on the route. As a further

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aid use was made of the Coast Survey charts of the vicinity, and especially of the maps of the Topographical Survey of the State of New Jersey just completed under the direction of George H. Cook, State geologist. Soundings were also made along the line of examination to verify the general information obtained as to the depth of water.

Two sheet of the Topographical Survey of the State of New Jersey, entitled "Topographical map of the peninsula of Cape May" (Atlas Sheet No. 17) and "Topographical map of Egg Harbor and vicinity" (Atlas Sheet No. 16), are submitted herewith, to which reference is made in the subjoined report.

Between Cape May and Great Bay, the limits of the present examination, the coast frontage consists of a salt-marsh meadow from 2 to 6 miles wide, lying between the mainland and the coast line. This marsh area is traversed by numerous connecting water-ways, ramifying from the ocean inlets. The water areas consist of passages from 100 to 1,600 feet in width, called channels and thoroughfares, and in expansive areas frequently covering several square miles, called bays and sounds.

The surface of the marsh is from 4 to 5 feet above mean low water, and is covered by the high water of storm tides. Between Cape May and Great Bay there are nine ocean inlets, named as follows: Cold Spring, Turtle Gut, Hereford, Townsend's, Corson's, Egg Harbor, Absecon, Brigantine, and New Inlet. These inlets are from one quarter to one mile in width, and carry from 6 to 10 feet of water over the bars at their mouths.

The mean range of the tides along this part of the coast is about 4 feet, and the ebb and flood through these inlets produce a corresponding change in the height of water in the inland water areas. As the flood tide enters the inlets it passes inland by the various connecting water-ways to the right and left. As a result, there is a point of meeting in these inland water-ways of the flood coming from adjacent inlets, and, consequently, at such points of meeting of the tide there exists only a vertical movement of the tidal-wave. The exact point of meeting of the tides depends upon the direction of the wind. On account of the absence of tidal currents at the meeting of the tides there ensues a slow deposition of the material held in suspension, and, as would naturally be expected, the water is very shallow over the area covered by these points of meeting. Such a shallow area in the inland waters exists between each successive pair of inlets, with but one modification, viz, between Corson's and Egg Harbor inlets, where two shoal areas occur, one in Crook Horn Thoroughfare and the other in Peck's Bay. This may be only an apparent departure from the rule, since present indications make it very possible that at some time in the past an inlet existed, but subsequently closed, between Corson's and Egg Harbor inlets.

The cross-section of the inlets is such as to allow of the passage of large quantities of water into the inland areas at flood tide, and the escape of this volume at the ebb results in considerable concentration of currents at special localities, and a consequent deepening of the inland passages at such points of concentration. The depth of water in the thoroughfares, channels, bay, and sounds is very variable in different localities, but in general terms it may be said that by selecting the deepest connecting water-ways over 6 feet can be covered at mean low water from Cape May to Great Bay, except at the divides or shallow areas just described; over these shallow areas the depth at mean low tide would average less than 1 foot.

The air-line distance between Cape May City and Great Bay is about 47 miles, but this distance would be increased to about 63 miles if the line of best water is followed. Such a line is shown on the accompanying maps by a dotted black and red line, the black line indicating the water having a present navigable depth of 6 feet and over, and the red line indicating the water having a depth at mean low water of less than 1 foot. In the present condition of the inland passages the small boats which navigate them must pass these divides at high water. These boats ordinarily draw from 1 to 2 feet of water.

The following summary shows the location and approximate length of these divides or shoal areas:

Between inlets of:—	Location of divide.	Length.
		Yards.
Cold Spring—Turtle Gut	Jarvis Sound	1,400
Turtle Gut—Hereford	Grassy Sound	1,200
Hereford—Townsend's	Great Sound	1,500
Townsend's—Corson's	Ludlam Thoroughfare and Bay	2,000
Corson's—Egg Harbor	Crook Horn Thoroughfare	3,000
	Peck's Bay	1,700
Egg Harbor—Absecon	Beach Thoroughfare	1,800
Absecon—Brigantine	Grassy Bay	2,300
Brigantine—New (Great) Bay	Little Bay	2,000
Total		16,900

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The land areas immediately along the coast line and at the inlets are composed of drifting sand and the detailed configuration of the high and low water lines change with each storm. Directly behind the sand border of the coast are the salt marshes, which are entirely free from sand, consisting of a tough black soil, apparently the result of slow deposits and vegetable growth, closely knit together with the roots of the marsh grass. The beds of the thoroughfares and channels seem to consist of the same material. The same description would generally cover the bottoms of the bays and sounds, although here are sometimes to be found gravel and sand bars. Oysters thrive in these inland waters, which is a further confirmation of the statement that moving sand does not generally exist in the bars of these inland waters. The water away from the inlets both at flood and ebb seemed very free from transported or suspended matter, and all indications suggest the extreme stability of present depths.

As shown by the previous summary, about 17,000 linear yards, or 9¼ miles, of waterway would require to be improved so as to give a navigable channel at low water between Cape May and Great Bay. If such a channel was improved to a width of 25 yards there would have to be removed about 150,000 cubic yards of material, measured in place, for each foot in depth of channel excavated, or to obtain a channel 6 feet deep at mean low water about 1,000,000 cubic yards would require to be dredged. This I consider a minimum quantity, for the reason that a detailed survey might show a still greater extent of shoal water, but would not probably show less than that above stated.

Although the character of the material which would require to be excavated is such as to make the cost of lifting it comparatively small, still the difficulty of disposing of dredged material would be such as to probably make the cost of excavation at least 25 cents, and possibly 30 cents, per cubic yard. The channels which would require improvement are, as will be seen from the maps, long, and in many cases very tortuous. An improved channel of a width within the limits of reasonable economy would, under such conditions of length and crookedness, be too narrow for sailing vessels; consequently, to utilize such improved channels at all stages of wind and tide, steam-vessels of light draught would have to be generally employed as the motive power.

As bearing upon the utility of an improvement of the thoroughfare between Cape May and Great Bay the following statement may be of interest. The coast line between these limits is broken by the inlets into the following-named beaches: (1) Poverty; (2) Two Mile; (3) Five Mile; (4) Seven Mile; (5) Ludlam; (6) Peck's; (7) Absecon; (8) Brigantine; and (9) Island. Of these the second, fourth, eighth, and ninth have no railroad connection with the mainland. These beaches, on account of their facilities for summer bathing, have developed a number of summer resorts, such as Cape May, Sewell's Point, Sea Isle City, Ocean City, Somers Point, and Atlantic City. These have already attained considerable development, while several others, such as Holly Beach, Anglesea, Longport, South Atlantic, Brigantine, and Island Beach, are in their early stages of development. The impetus which of late years has been given to sea-side resorts has given great value to the beaches already developed, and a large speculative value to the beach partially, or even totally, unimproved. To develop these beaches it is of the first importance that they be made very accessible to the public. Such beaches as already have railroad connection with the mainland have a great advantage over beaches lacking such facilities.

If the thoroughfares, bay, and sounds were made navigable for steam-vessels of light draught, then the beaches with present railroad connection could be made available as points for still further distribution and expansion, thereby opening to the sea-side resorting public new advantages, and to the owners of the beaches rich remuneration. These inland waters are well adapted to the growth of oysters, and considerable enterprise seems to have already been applied in this direction. With increased facilities for reaching the market this industry could be indefinitely expanded. In this connection it might be worthy to note, in passing, that the existing privileges of occupation of these waters for the oyster fisheries are obtained from the State of New Jersey simply by pre-emption, the right holding good as long as the fisheries are properly cared for. In case an improvement was made of the channels it would probably be found that owners of fisheries would claim indemnity for the injury or destruction to oyster fisheries that might result from local interference with the beds of the water areas.

The development of the beaches would for several months of each year add a large population to this district, for the subsistence of which the adjacent mainland offers excellent facilities, and an improved water communication through these inland waters would still further develop the immediate mainland and add something of value to producers, and possibly to consumers. These prospective advantages are contingent upon conditions which it is possible to anticipate with sufficient probability to make them assurances, and although perhaps bearing upon the question of whether

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the work is worthy of improvement, still leaves the necessity for such improvement far short of one of national importance.

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers, U. S. A.

STATEMENT OF C. K. LANDIS ABOUT THE THOROUGHFARE IMPROVEMENT BETWEEN CAPE MAY AND GREAT BAY, NORTH OF ATLANTIC CITY, NEW JERSEY.

SEA ISLE CITY, *November* 11, 1886.

SIR: I beg leave to call your attention to the following reasons which make it just, proper, necessary, and profitable for the Government of the United States to perform the work for improving the navigation of the thoroughfare between the Great Bay, north of Atlantic City, and Cape May, which has been so largely petitioned for by petitions signed by many hundreds, if not thousands, of people. The length of this thoroughfare, including sinuosities, is about 60 miles. At Great Bay it reaches Barnegat Bay, which extends the navigation 40 miles farther north, to Point Pleasant. Practically, this improvement will make an inside navigable stream for steamers and sailing vessels drawing not over 8 feet of water for a distance of 100 miles. The natural formation of land and water in this district makes it peculiarly important that the waters should be made navigable, in order that the population of the place, and also the population of the neighboring States, should have the advantage and benefit of the natural resources and riches of this district. The land on the western side of the thoroughfare consists of meadow land, filled with bays and sounds, now occupied as oyster-beds, and an alluvial deposit, making the most productive farm land in the State of New Jersey, which farm land is continuous for the whole distance and in a high state of improvement, divided up into small farms, and embracing a large population. These farm-houses in summer-time are most all boarding-houses.

The entire distance of 100 miles is lined with numerous villages, boroughs, and several cities. The district is only reached at several points by railroads, which run at right angles with it, and not parallel, to accommodate the commerce; and in fact the products of this district can better be accommodated by navigation than by railroad.

In this immediate district, commencing at the Great Bay and near by and adjacent to the proposed improvement, are the following villages, boroughs, and cities: Brigantine, Leedspoint, Oceanville, Summerville, Conoverville, Absecon, Atlantic City, South Atlantic City, Longport, Pleasantville, Smith Landing, Bakersville, Leedsville, Sea View, Somer's Point, Ocean City, Beesley's Point, Palmero, Ocean View, Sea Isle City, Seaville, Clermont, Swain, Oceanville, Cape May Court House, Anglesea, Holly Beach, Rio Grande, Sewell's Point, Bennett's, Cape May City.

These places have all, more or less, a numerous population, permanent for the entire year, and visited during the year by people from New York, Philadelphia, Baltimore, Washington, and the Far West by fully 1,000,000 of people, and which within the next ten years will probably reach 3,000,000, if the increase of the future compares with the increase of the past ten years. This population requires a constant supply of the produce to be obtained from the farms, bays, and sounds adjacent to the proposed improvement, and which commerce is almost entirely obstructed by the alluvial deposits in the track of navigation, which all can be removed for comparatively a small sum when the benefits are to be taken into consideration.

These benefits are not of a local character, but in their nature are general, and for the supply of farm produce; also oysters and other products of salt water. Philadelphia, New York, Boston, and other places will come in for a direct share of the benefits; which cities will also be able to have delivered building materials along the entire thoroughfare when made navigable. The waters, planted with oysters, and also abounding in clams, crabs, fish, etc., besides the thoroughfare itself, when of a proper width, may be said to be the following: Great Bay, Little Shad Bay, Reed's Bay, Grass Bay, Absecon Bay, Lake's Bay, Great Egg Harbor Bay, Peck's Bay, Ludlam's Bay, Great Sound, Jenkin's Sound, and Jarvin's Sound.

These waters are now planted with oysters, but the commerce is now largely crippled and limited by the want of navigation, and the value of all this product, with proper navigation, will amount to millions per annum, which value is now largely lost or locked up by these alluvial deposits in the line of navigation, which interfere with commerce. The improvements of this thoroughfare will also be a vast protection to the coasting trade. Vessels now drawing over 1 foot of water are compelled to go outside, and then go into the thoroughfare by one of the different inlets, in order

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to get from one point to the other. This improvement will also be a protection to outside commerce, because, if made, in case of storm, vessels that do not draw too much water can run into different inlets and find a secure harbor, or keep on their course north or south by the proposed water-way.

To show that there is ample opportunity for this, attention is called to the fact that the following inlets exist, commencing at Great Bay and extending to Cape May: Little Egg Harbor Inlet, Brigantine Inlet, Absecon, Great Egg Harbor, Corsin's, Townsend's, Hereford's, Turtle Gut, and Cold Spring inlets. To give an estimate of the probable commerce which would develop in case this improvement is made is difficult. This whole district, to a certain extent, has been locked up from commerce for the want of navigation. To afford it navigation, and, owing to the peculiarity of its products and the proximity of millions of people, to now give it navigable facilities will be like the unlocking of a mine.

The benefits to be derived are such as to reach the population of a wide scope, and without exaggeration we may say millions of people. As soon as the work is finished steamers and sailing vessels will be navigating the waters, carrying the products to adjacent watering-places and to the large cities of the Atlantic sea-board. The results of so great an improvement are self-evident, considering the great extent of population and number of villages and cities interested in this commerce.

Most respectfully, your obedient servant,

CHAS. K. LANDIS.

Lieut. Col. HENRY M. ROBERT.

LETTER OF MR. ISAAC A. BRADDOCK.

HADDONFIELD, N. J., *November* 17, 1866.

SIR: I have been shown a statement to you regarding the proposed improvement of the inside coast-line of New Jersey, clearing the mud-bars, etc., at the head of the thoroughfares, and making them continuously navigable from Cape May to Great Bay, which amounts to opening navigation inside from near Long Branch to Cape May. I thoroughly indorse the feasibility of the undertaking, and add to the testimony of C. K. Landis that this is a matter of interest to nearly a fourth of the population of the country, as this ocean border of New Jersey is the sanitarium and summer recruiting-ground of people from at least a dozen States. If this improvement was made, numerous small steamers would be put on to furnish cheap and pleasant communication between the different summer resorts on this coast that are so crowded in the season with people desirous of enjoyment and spending their money liberally in the pursuit of health. To wait on these people, who are from many different States, there is a numerous, industrious, and hardy set of fishermen and farmers, who, for want of this convenience, are frequently compelled to spend a night fast in the mud with their load of oysters, hay, fish, or farm produce, or to brave an angry sea in a small vessel to get from inlet to inlet outside.

The United States Government are about to order a survey for a ship-canal from Philadelphia to Great Bay, which, if constructed (and it is possible to do it), would then strike this 100 miles of improved navigation nearly central, and enable steam-yachts to steam and sailing vessels of all sizes to take an inland passage from North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New York, Connecticut, and Rhode Island, and reach this point without getting more than a distant view of the sea and its dangers. The cost of this improvement, as you would see on examination, need not be large, as the excavations are either in mud or sand, and could all be done by steam-dredges of the cheapest construction, and easily afterward maintained, as the bars to be removed are not opposite or adjacent to the inlets (as there as a rule is the deepest water), but at about the middle of the coast-lying beaches, where the tides meet, and have probably been hundreds of years, if not thousands, in slowly depositing a rich, fine mud, that in many cases would pay largely for removal as a fertilizer, as it is very rich in phosphatic deposits. I believe if this navigation was opened there would be numerous parties engaged in the business of preparing fertilizers of fish and phosphatic deposits, which, with cheap and easy navigation, could be distributed to the States mentioned above to the advantage of their agriculture.

These are a few of the points which I desire to suggest, and if it were necessary many others could be indicated which call for this cheap and necessary improvement.

Very respectfully,

ISAAC A. BRADDOCK.

Lieut. Col. H. M. ROBERT.

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SURVEY OF THE THOROUGHFARE RUNNING BACK OF THE OCEAN FROM CAPE MAY TO THE GREAT BAY NORTH OF ATLANTIC CITY, NEW JERSEY.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., April 25, 1888.

SIR: I have the honor to submit the following report on the survey of the thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J.

This survey was made during August, September, and October, 1887, and since then has been plotted by Mr. Feodor Sylvester, under the supervision of Asssistant Engineer L. Y. Schermerhorn. As the thoroughfares are at places less than 100 feet wide, it was necessary to plot the survey on a scale of 200 feet to the inch, and as the length of the route surveyed is 65 miles, the map of the survey covers thirty-four sheets. The actual length of water-way surveyed was 70 miles.

A copy of Assistant Engineer L. Y. Schermerhorn's full report of the survey, together with thirty-five sheets of tracings (one index sheet and thirty-four sheets of detail) are forwarded herewith as a part of this report.

The survey shows that to obtain a 6-foot channel at least 50 feet wide at the bottom it is necessary to improve about 20 miles of the route by dredging some 1,310,000 cubic yards of material, scow measurement. Of this amount 430,000 cubic yards are north of Atlantic City, within 5 miles of Great Bay, leaving about 880,000 cubic yards to be dredged in the 55 miles between Atlantic City and Cape May. The dredging of 114,000 cubic yards from 2 miles of channel would connect the Tuckahoe River with Atlantic City by a good 6-foot channel at low water, which would prove a great benefit to those living on that river.

In estimating the amount of dredging I have taken 6 feet as the depth to be maintained at low water, and have had the calculations all made to 7 feet depth, in order to insure the proper depth. The width at this depth of 7 feet is taken at 50 feet, and the side slopes at 1 vertical to 3 horizontal, so that the width at 3 feet below low water would be 74 feet, or about the same as the 6-foot channel, with a mean width of 75 feet, recommended in my preliminary report dated December 24, 1886.

The quantity of material has been reduced to scow measurement by adding 20 per cent. to place measurement, because in practice it probably would be measured either in the dipper or in scows.

It does not seem to me that a greater width than 50 feet at 6 feet below low water is necessary in the dredged channel. A channel of this width can be dredged economically by making two cuts with a dredge and throwing the material to the sides, thus saving the expense of scowing it away or procuring the plant for placing it on the shores.

By adopting this method I think that contracts could be made at much lower rates than estimated in my preliminary report. Assuming appropriations commensurate with the work, I think $200,000 ought to suffice to complete the work by contract.

But a work of this nature should never be done by contract. There are no dredges along the whole line of the improvement and no private business requiring them. Even after the work is completed it is not to be expected that 20 miles of dredged channel will take care of itself. Allowing only 5 per cent. of the original amount for the annual dredging to preserve the channel, and there will be 65,000 cubic yards of dredging to be done each year, which could be done by a Government

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dredge on the ground for one-half what it would cost to have the work done by contract.

The entire cost of the plant would be much more than saved in doing the original dredging, as the 1,310,000 cubic yards could be dredged with a Government dredge at a cost not to exceed $130,000, including the cost of plant. At the close of the work the Government would, in my judgment, have saved at least $70,000, besides having a good plant on hand, which would be needed for preserving and enlarging the channel.

In case this work were undertaken it could be utilized long before its completion. As before stated, it requires the dredging of only 114,000 cubic yards to connect the Tuckahoe River and Great Egg Harbor with Atlantic City by a 6-foot channel. After that work is done it would probably be best to cut a 4-foot channel first and afterwards deepen it to 6 feet.

ESTIMATE.

I would estimate the amount of material to be dredged to make a channel 6 feet deep at mean low water and 50 feet wide at bottom at 1,310,000 cubic yards and the cost at $200,000, if done by contract, or $130,000 if the Government builds its own plant and does the work by hired labor.

If an appropriation is made for this work it should not be less than $40,000 to begin with. Afterwards smaller appropriations would answer.

I have been unable to procure any commercial statistics, and nothing further has been obtained relating to the commercial importance, present and prospective, of the improvement contemplated than is contained in my preliminary report.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. L. Y. SCHERMERHORN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., April 17, 1888.

SIR: I have the honor to submit the following report upon the survey of the Thoroughfare running back of the ocean from Cape May to the Great Bay north of Atlantic City, N. J.

In November, 1886, an examination was made of this route and a report thereon submitted to the Department under date of December 24, 1886. From the results of this examination a survey was recommended and authorized under an allotment of $1,885. The field work of the survey was commenced August 12 and completed October 21, 1887. This work was personally conducted by Mr. Feodore Sylvester, and covered 70 linear miles of water-way, with about 25,000 soundings.

The topography of the maps was mainly reproduced from the latest plane-table sheets of the U. S. Coast and Geodetic Survey, corrected for changes which have taken place since that survey was made. The results of the present survey are shown on thirty-four sheets upon a scale of 200 feet to 1 inch.

The following description of the physical characteristics of the route is derived from my report dated December 7, 1886, on the examination made in November of that year:

"Between Cape May and Great Bay the coast frontage consists of a salt-marsh meadow from 2 to 6 miles wide, lying between the mainland and the coast line.

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This marsh area is traversed by numerous connecting water-ways, ramifying from the ocean inlets. The water areas consist of passages from 100 to 1,000 feet in width, called channels and thoroughfares, and in expansive areas frequently covering several square miles, called bays and sounds.

"The surface of the marsh is from 4 to 5 feet above mean low water, and is covered by the high water of storm tides. Between Cape May and Great Bay there are nine ocean inlets, named as follows:

"Cold Spring, Turtle Gut, Hereford, Townsend's, Corson's, Egg Harbor, Absecon, Brigantine, and New Inlet. These inlets are from one-fourth to 1 mile in width, and carry from 4 to 10 feet of water over the bars at their mouths.

"The mean range of the tides along this part of the coast is about 4 feet, and the ebb and flood through these inlets produce a corresponding change in the heights of water in the inland water areas. As the flood tide enters the inlets it passes inland by the various connecting water-ways to the right and left. As a result, there is a point of meeting in these inland water-ways of the flood coming from adjacent inlets, and consequently at such points of meeting of the tide there exists only a vertical movement of the tidal wave. The exact point of meeting of the tides depends upon the direction of the wind. On account of the absence of tidal currents at the meeting of the tides, there ensues a slow deposition of the material held in suspension, and, as would naturally be expected, the water is very shallow over the area covered by these points of meeting. Such a shallow area in the inland waters exists between each successive pair of inlets, with but one modification, viz:

"Between Corson's and Egg Harbor inlets, where two shoal areas occur, one in Crook Horn Thoroughfare and the other in Peck's Bay. This may be only an apparent departure from the rule, since present indications make it very possible that at some time in the past an inlet existed, but subsequently closed, between Corson's and Egg Harbor inlets.

"The cross-section of the inlets is such as to allow of the passage of large quantities of water into the inland areas at flood tide, and the escape of this volume at the ebb results in considerable concentration of currents at special localities and a consequent deepening of the inland passages at such points of concentration."

The depth of water in the thoroughfares, channels, bays, and sounds is very variable in different localities. In the narrower water-ways depths of from 30 to 40 feet frequently occur, while in the broad areas of the bays and sounds the ruling depth is about 1 foot.

The land areas immediately along the coast-line and at the inlets are composed of drifting sand, and the configuration of the bars at the mouths of the inlets materially change with each violent gale. Directly behind the sand border of the coast lie the salt marshes traversed by the water-ways under consideration. The land areas of these marshes consist of a tough, black soil, apparently the result of slow deposit and vegetable growth, closely knit together with the roots of the marsh grass.

The shore-lines of the water-ways rise with nearly a vertical face from 1 to 2 feet above mean high water, and present surfaces quite easily eroded by the action of currents and storms. The banks are thickly perforated with the holes of sand-fiddlers and craw-fish, and through their action a slow disintegration of the banks is constantly in progress.

The beds of the water areas consist of mud, except in the vicinity of the inlets, where sand is found. Occasionally sand and gravel bars, bare at low water, occur away from the inlets, but such material forms only in exceptional cases any part of the beds of the thoroughfares and sounds. The character of the mud covering the bottom suggests that its source of supply is derived from the decaying banks. The water away from the inlets is very clear and free from suspended matter, which indicates that the process of deposition must be exceeding slow.

The bays and sounds are universally shoal, carrying about 1 foot depth at low water, except in narrow and tortuous drains, which are very unstable in position, with a tendency to shift under the varying influences of storm tides. The unstable condition of the forces which seem to operate in these bays and sounds will militate seriously against the improvement of the proposed line of water communication, since a large part of the water-way requiring improvement lies through these shallow bays and sounds.

Upon the accompanying maps the 6-foot curve of depth is shown in blue and the line of best depth in dotted red. Along the line in red the distance from the point of beginning at Schellinger's Landing, Cape May, is marked by numbered stations 500 feet apart; the distances from Cape May, in miles, is also noted on this line. The distance in an air line between the initial point at Cape May and deep water in Great Bay is about 47 miles. By the line of best water this distance is increased to 65 miles.

The following statement shows the amount of excavation in cubic yards, scow measurement, which would require to be removed to form channels, respectively 4 and 6 feet deep, with widths of 50, 75, and 100 feet. All excavation has been calcu-

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lated to 1 foot below the depth named, and in reducing the quantity of material to scow measurement 20 per cent. has been added to the quantity in situ.

The first column, marked "miles," indicates the mile, numbering from Cape May, in which the natural channel requires improvement to give channels of the stated depths and widths. The column adjacent to "miles" indicates the length of natural channels requiring improvement in each mile of route specified.

Miles.	Depth of channel, 4 feet.				Depth of channel, 6 feet.			
	Length.	50 feet wide.	75 feet wide.	100 feet wide.	Length.	50 feet wide.	75 feet wide.	100 feet wide.
	Feet.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
1	600	6,000	23,000	40,000	5,280	15,000	51,000	88,000
3					200		2,000	3,000
4	3,500	34,000	47,000	60,000	5,600	64,000	89,000	114,000
5					4,000	23,000	64,000	104,000
6	1,700	10,000	19,000	28,000	2,500	22,000	37,000	50,000
7	2,600	12,000	26,000	40,000	3,300	27,000	41,000	56,000
8	4,650	22,000	32,000	42,000	5,280	52,000	72,000	95,000
19	4,650	40,000	56,000	72,000	5,280	72,000	100,000	130,000
26	3,100	14,000	21,000	27,000	4,600	35,000	52,000	67,000
27	4,100	34,000	47,000	61,000	4,300	58,000	86,000	113,000
28	4,000	34,000	48,000	62,000	4,400	62,000	85,000	110,000
32					500		10,000	20,000
33	3,800	33,000	46,000	60,000	4,000	57,000	87,000	120,000
34	3,950	30,000	41,000	54,000	5,000	49,000	70,000	112,000
35	2,100	31,000	53,000	74,000	3,000	58,000	85,000	132,000
37	4,000	40,000	55,000	72,000	4,200	68,000	94,000	120,000
38	4,000	41,000	58,000	74,000	4,300	70,000	95,000	121,000
39	3,000	12,000	17,000	22,000	3,600	33,000	46,000	60,000
48					500			3,000
49					3,000			14,000
50	4,500	41,000	56,000	71,000	5,000	68,000	94,000	120,000
51	2,600	25,000	37,000	49,000	3,400	46,000	66,000	85,000
60					1,900	7,000	11,000	14,000
61	5,280	67,000	93,000	120,000	5,280	106,000	143,000	181,000
62	5,280	67,000	93,000	120,000	5,280	106,000	143,000	181,000
63	5,280	67,000	93,000	120,000	5,280	106,000	143,000	181,000
64	5,280	67,000	93,000	120,000	5,280	106,000	143,000	181,000
	77,970	727,000	1,054,000	1,388,000	103,660	1,310,000	1,909,000	2,575,000

From the foregoing table it will be seen that the length of channel requiring improvement to secure a low-water depth of 4 feet is about 15 miles, while for a 6-foot depth it is about 20 miles. In considering the probable cost of any one of the six plans for which estimates of quantities are given in the foregoing table, it may be assumed safely that the greatest economy will result from simply casting over into a bank parallel to and directly alongside of the proposed channels as much of the dredged material as can be so placed with a single handling. By this method of disposal the material removed by scows will be reduced to a minimum, with a direct saving in the cost of the work.

It can be assumed that a dredge can carry a cut 25 feet wide and at the same time bank the dredged material directly from the dipper. For channels 50 feet wide this would result in allowing all dredged material to be deposited directly by the dredge on an adjacent bank by carrying two parallel cuts, each 25 feet wide. If the channel is increased to 75 feet width, then one cut must be cast over the second time or else removed in the first handling by scows. If the channel is made 100 feet wide, then one-half the quantity of excavation must be removed by scows.

Even assuming that it is as economical to rehandle with the dredge as to remove with scows, it will be found in the excavation of the channels through the shoal areas, where often the depth of excavation is fully as great as the depth of channel proposed, that there will not be room on each bank for the deposition of more material than that which is derived from a single cut 25 feet wide.

A dredge would be obliged to keep a tug at hand, even though no material was scowed away, to assist in movement from place to place and to keep up the supply of coal, fresh water, and supplies. But for such service a smaller tug would suffice than that required for towing scows. I would estimate the cost of the removal of all material which can be banked by the dredge with a single handling at 15 cents per cubic yard, and for all material which requires to be dredged and removed by scows at 20 cents per cubic yard, upon the assumption that appropriations were available so as to permit of an annual expenditure of from $40,000 to $50,000 from the com-

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mencement to the completion of the work. Upon this basis the cost of the several plans would be as follows:

Four-foot channel, 50 feet wide:	
730,000 cubic yards, at 15 cents	$109,500
Superintendence and contingencies	10,500
	120,000
Four-foot channel, 75 feet wide:	
700,000 cubic yards, at 15 cents	105,000
350,000 cubic yards, at 20 cents	70,000
Superintendence and contingencies	20,000
	195,000
Four-foot channel, 100 feet wide:	
700,000 cubic yards, at 15 cents	105,000
700,000 cubic yards, at 20 cents	140,000
Superintendence and contingencies	25,000
	270,000
Six-foot channel, 50 feet wide:	
1,310,000 cubic yards, at 15 cents	196,500
Superintendence and contingencies	20,500
	217,000
Six-foot channel, 75 feet wide:	
1,270,000 cubic yards, at 15 cents	190,500
640,000 cubic yards, at 20 cents	128,000
Superintendence and contingencies	31,500
	350,000
Six-foot channel, 100 feet wide:	
1,300,000 cubic yards, at 15 cents	195,000
1,300,000 cubic yards, at 20 cents	260,000
Superintendence and contingencies	45,000
	500,000

The northern 4 miles of the route, or that part of the line through Grassy and Little bays, is through continuously shoal water less than 1 foot deep. It will be seen from the previous table that the excavation through the 61, 62, 63, and 64 miles of the route is nearly one-third of the entire amount. If Atlantic City be made the northern terminus of the route, the work required on the last 4 miles of the line, between Cape May and Great Bay, would be eliminated and the foregoing estimates reduced about one-third.

In relation to the permanency of the dredged channels, it is difficult in all cases to reach satisfactory conclusions. In the thoroughfares and narrow water-ways I believe that improved channels can be maintained by the action of tidal currents, but in the long dredged cuts which would be required across the bays and sounds there are strong reasons against the presumption of permanency.

The length of the artificial channels required across these broad and shallow water areas are as follows: Jarvis's Sound, four-fifths of a mile; Grassy Sound, 1 mile; Leaming's Bay, 1½ miles; Ludlam's Bay, 1 mile; Peck's Bay, 1¼ miles; Grassy and Little bays, 4 miles.

To render such long narrow channels usable, it is necessary that they should be on lines which can be defined by ranges, and there can be no assurance that such lines will be coincident with the direction of prevailing tidal currents, especially when the set of the most energetic currents depends upon the direction of storm winds. Some of the bays and sounds are several miles in extent, and with such a reach waves of considerable amplitude are formed under the impulse of the wind. Such waves moving through the very shoal water, transverse to the direction of the dredged channel, would tend to refill the artificial channel just as the waves efface and change the tortuous drains formed by the tidal currents through the broad shoal areas.

Through the narrow water-ways, channels which follow the trend of the shore-lines will not be lacking in definition since they can be easily identified with the configu-

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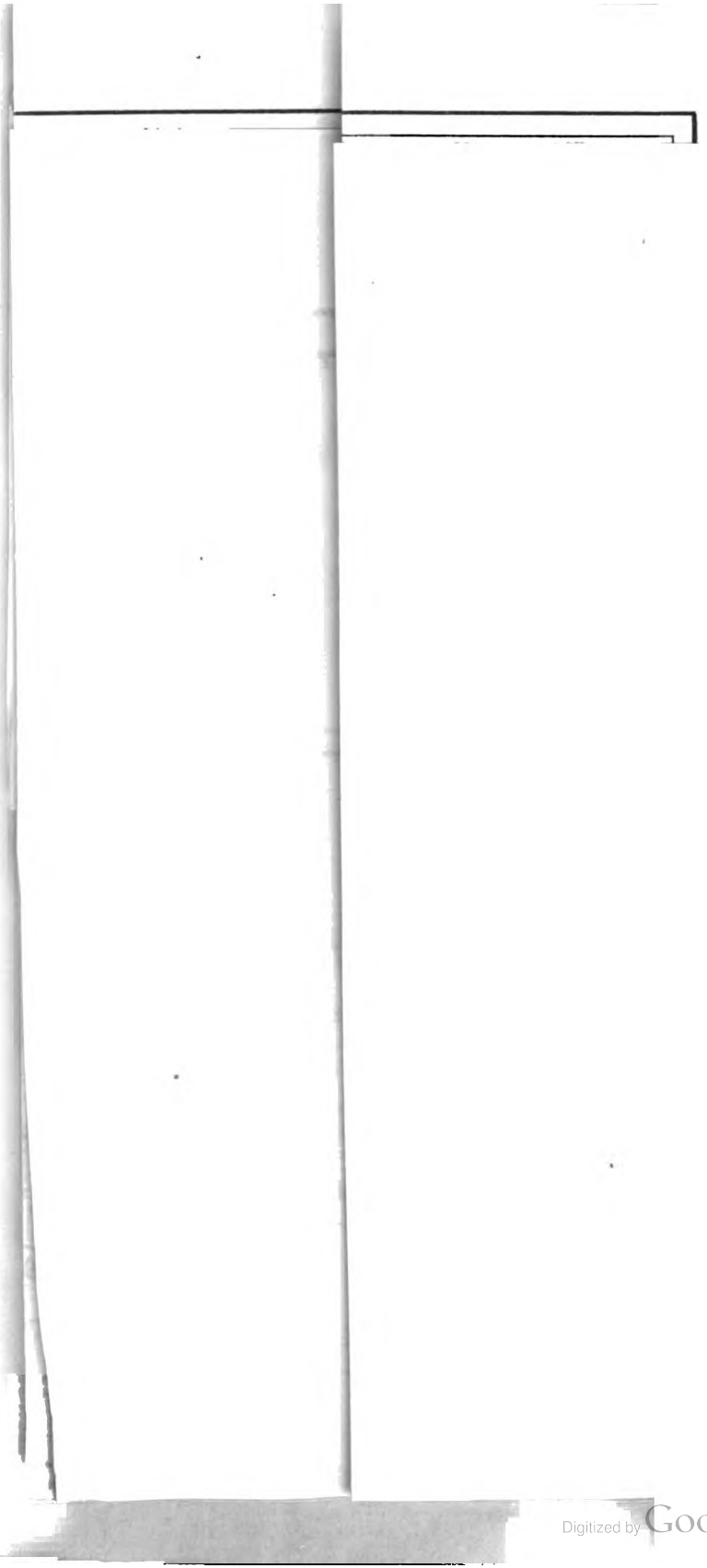
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ration of adjacent shore-lines. An inspection of the maps will clearly indicate that any improved channels which are possible will be too narrow and circuitous to render them of value to sailing vessels, and that consequently they would only be of value to craft moved by steam.

The formation of banks along each side of improved channels by the deposition of dredged material will generally cause them to act as deflecting dikes and probably materially aid in the maintenance of the improved channels. At the ends of the dredged channels the excavated material could be easily disposed so as to form flanking embankments, which would aid in concentrating the currents upon the improved channels. It is highly probable that valuable results in the way of diversion and concentration could be accomplished at many points by closing side channels with embankments of dredged material.

The beds of the water-ways through which the route under consideration passes are of considerable value as oyster fisheries. In any plan for the improvement of these water-ways there would necessarily arise objections to interference with, and injury to, the private interests involved in these oyster fisheries. To what extent the formation of dredged channels and the deposition of dredged material would injure those oyster interests, I am unable to form an opinion; parties in interest have stated that the injury would not be inconsiderable.

In closing I desire to testify to the valuable services rendered by Mr. Feodore Sylvester, and to commend the energy and intelligence with which the survey and the plotting of the maps was carried on under his personal supervision.

Very respectfully, your obedient servant,

L. Y. SCHERMERHORN,
Assistant Engineer.

Lieut. Col. HENRY M. ROBERT,
Corps of Engineers.

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APPENDIX H.

IMPROVEMENT OF HARBORS AND RIVERS IN THE STATES OF DELAWARE AND MARYLAND, AND OF MAURICE RIVER, NEW JERSEY, AND THE INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY.

REPORT OF MR. WILLIAM F. SMITH, UNITED STATES AGENT IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1888, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Maurice River, New Jersey.
2. Wilmington Harbor, Delaware.
3. Ice-harbor at New Castle, Delaware.
4. Duck Creek, Delaware.
5. Saint Jones River, Delaware.
6. Mispillion Creek, Delaware.
7. Broadkiln River, Delaware.
8. Indian River, Delaware.
9. Inland water-way from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Delaware.
10. Susquehanna River above and below Havre de Grace, Maryland.
11. Chester River at Kent Island Narrows, Maryland.
12. Corsica Creek, Maryland.
13. Choptank River, Maryland.
14. Nanticoke River, Delaware.
15. Broad Creek, Delaware, from its mouth to Laurel.
16. Wicomico River, Maryland.
17. Upper Thoroughfare between Deil's Island and the mainland.
18. Pocomoke River, Maryland.
19. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., July 9, 1888.

SIR: I have the honor to transmit herewith the annual report for the fiscal year ending June 30, 1888, of the works of river and harbor improvement in my charge.

I was assisted by Mr. Charles Humphreys, assistant engineer, in the prosecution of these works during the first five months of the fiscal year.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

The CHIEF OF ENGINEERS, U. S. A.

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H 1.

IMPROVEMENT OF MAURICE RIVER, NEW JERSEY.

Proposals were opened on July 21, 1887, for continuing this improvement with the appropriation of August 5, 1886, and a contract entered into with the American Dredging Company, of Philadelphia, Pa. The work was commenced on the 8th of August, 1887, and continued without interruption until the 20th of October, 1887.

Previous work has been to dredge a channel 100 feet wide from a point 4 miles below Millville to within 5,000 feet of that place, and from thence to Millville 50 feet in width; all to a depth ranging from 5 to 6 feet at low water.

The work during the present fiscal year consisted in widening the 50-foot channel to 100 feet in width at bottom, a distance of 3,050 feet, making the depth 6 to 7 feet at low water. The total number of cubic yards of material removed was 29,363, which was deposited on the banks from 50 to 100 feet from the nearest edge of the channel by a long boom and force pump.

There is now an average 6-foot low-water navigation to within 5,350 feet of Millville. The effect of the work done is already of much benefit to commerce and navigation, and the people interested are pleased with the results thus far accomplished.

An appropriation of $20,000 is recommended for the fiscal year ending June 30, 1890, and if appropriated will be applied to continuing the dredging for a 6-foot low-water navigation 100 feet in width over the 4 miles of the river below Millville.

Credit is due the contractor for the prompt and efficient manner in which the work was prosecuted.

The estimated value of commerce on the river is $1,821,585. The tonnage of vessels owned on the river aggregates 11,000 tons. The completion of the proposed improvement will open a competing route of transportation to the business of Millville valued from $7,000,000 to $8,000,000, and which consists principally of the manufacture of iron pipe, glass, and both manufacture and dyeing of cotton goods.

This work is in the collection district of Bridgeton, New Jersey, which is also the nearest port of entry. Amount of revenue collected the last fiscal year is $188.78.

AMOUNTS APPROPRIATED.

By act passed August 2, 1882	$3,000
By act approved July 5, 1884	17,000
By act approved August 5, 1886	5,000

Money statement.

July 1, 1887, amount available	$4,967.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	4,952.42
July 1, 1888, balance available	14.84
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1889	10,014.84
Amount (estimated) required for completion of existing project	77,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals received and opened at 12 o'clock noon of July 21, 1887, by General William F. Smith, United States agent, for dredging in Maurice River, New Jersey.

No.	Name and address.	Time.		Price per cubic yard, place measurement.
		Commence.	Complete.	
				Cents.
1	American Dredging Company, Philadelphia, Pa.....	Aug. 20, 1887	Oct. 20, 1887	14

LETTER OF MR. O. W. WORSTALL.

MILLVILLE, N. J., *June* 30, 1887.

DEAR SIR: In answer to yours of 25th instant, I can say that I believe there is 10 to 20 per cent. more shipping on our river than there would have been had there been no improvements made; there are vessels come here carrying 300 to 500 tons, and built for this trade, which would not have been thought of before the improvements here made, and one great advantage is that it will be a check on the railroad. We can not be imposed upon very much if we have good water navigation. R. D. Wood & Co. are building another new vessel to trade here, and I hope you will soon be able to continue on up to the bridge with the good work that was done last.

Yours, respectfully,

O. W. WORSTALL.

General WM. F. SMITH,
U. S. Engineer.

H 2.

IMPROVEMENT OF WILMINGTON HARBOR, DELAWARE.

The condition of the harbor from its entrance to Market-street Bridge, in October, 1886, is given in the last Annual Report of the Chief of Engineers. At the close of the last fiscal year a channel 75 feet wide and 15 feet deep at low water had been dredged from Market-street Bridge to a point 6,200 feet from the outer end of the jetty. Dredging during the present fiscal year was continued under the contract with the National Dredging Company, dated February 10, 1887, to July 19, 1887, on which date work was suspended on account of the near exhaustion of the appropriation. There has been nothing done since. The channel, 75 feet wide and 15 feet deep at low water, was extended to the outer end of the jetty. The distance dredged was 3,000 feet, removing 31,111 cubic yards. After the dredging was suspended a survey was made of the dredged channel from Market street to the entrance of the harbor, and results show considerable filling just above Third-street Bridge and at the mouth of the Brandywine Creek.

This shoaling is due to the natural sloping of the sides of the cut (the depth of cutting in the above cases being from 4 feet to 12 feet in soft mud), vessels lying aground during low tide outside the channel and forcing the soft mud into the channel; unreasonable speed of the steamboats navigating a stream 300 to 400 feet wide; washing from the streets of Wilmington, and freshets in the Brandywine. At the points where the channel had shoaled the depth of water on the flats had increased.

The jetty at the entrance has remained in fair condition, and its effect has been to increase the depth except at the outer end where the tendency is to shoal. It is believed that this could be remedied by extending the jetty 322 feet further in the Delaware River, and in a direction to cause the ebb tide in the Delaware to unite parallel with ebb from the Christiana River.

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Owing to the small appropriations the work has been confined to dredging for the immediate relief of navigation. The amount recommended for the fiscal year ending June 30, 1890, is $75,000, and if appropriated will be applied to extending the jetty, and dredging to secure a 15-foot low-water navigation in accordance with the approved project.

It is estimated that $5,000 to $10,000 will be required annually to maintain the improvement. The maritime commerce of the port of Wilmington for the fiscal year ending June 30, 1888, is —— tons, valued at $——.

Wilmington is a port of entry, and in the collection district of Delaware. The amount of revenue collected for the fiscal year ending June 30, 1888, is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved July 14, 1836	$15,000
By act approved March 3, 1837	8,000
By act approved July 7, 1838	9,356
By act approved July 11, 1870	15,000
By act approved June 10, 1872	10,000
By act approved March 3, 1873	6,000
By act approved June 23, 1874	6,000
By act approved March 3, 1875	10,009
By act approved August 14, 1876	16,000
By act approved June 18, 1878	7,000
By act approved March 3, 1879	3,500
By act approved June 4, 1880	10,000
By act approved March 3, 1881	50,000
By act passed August 2, 1882	50,000
By act approved July 5, 1884	25,000
By act approved August 5, 1886	18,750

Two thousand four hundred and eleven dollars and twenty-two cents of the above appropriations have been carried to the surplus fund of the Treasury.

Money statement.

July 1, 1887, amount available	$8,199.26
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	6,033.05
July 1, 1888, balance available	2,166.21
Amount appropriated by act of August 11, 1888	30,000.00
Amount available for fiscal year ending June 30, 1889	32,166.21
Amount (estimated) required for completion of existing project	117,634.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H. 3.

ICE HARBOR AT NEW CASTLE, DELAWARE.

Operations during the present fiscal year consisted of placing 252 cubic yards of riprap around Piers K and N at bottom to prevent scouring, and repairing damages to Pier N caused by collision from a steamer.

The repairs required the removal of 20 stones from the south face, 3 from the back of the top course, and 13 pieces of paving stones. These stones, as well as those displaced by the collision, were all put in their proper places again and clamped. Four new clamps were also put on the northeast corner stone.

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A steam hoister was engaged and the work done by hire of labor and purchase of material in open market.

The amount asked for the fiscal year ending June 30, 1890, is $15,600, and if appropriated will be applied to rebuilding Pier H, which is in a most insecure condition, and the necessity of rebuilding it is urgent.

The dredging should also extend a short distance above and below the harbor to create a current to diminish the tendency to fill up.

New Castle is the only harbor of refuge from running ice in the Delaware River between the Delaware Breakwater and Marcus Hook, a distance of 76 miles. Its importance to navigation and commerce may be inferred from the fact that about two thousand vessels and steamers, all coastwise and foreign, seek refuge there during the ice season on the Delaware River.

The ice harbor of New Castle is in the collection district of Delaware, and Wilmington is the nearest port of entry.

The amount of revenue collected during the fiscal year is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved May 20, 1826	$25,000.00
By act approved March 2, 1829	17,695.99
By act approved July 2, 1836	25,000.00
By act approved March 3, 1837	10,000.00
By act approved July 7, 1838	11,573.00
By act approved August 30, 1852	15,000.00
By act approved July 15, 1870	2,500.00
By act approved June 10, 1872	27,000.00
By act approved March 3, 1873	20,000.00
By act approved June 27, 1874	10,000.00
By act approved March 3, 1875	20,000.00
By act approved August 14, 1876	12,000.00
By act approved June 18, 1878	10,000.00
By act approved March 3, 1879	5,000.00
By act approved June 14, 1880	3,000.00
By act approved March 3, 1881	20,000.00
By act approved July 5, 1884	2,000.00
By act approved August 5, 1886	5,000.00

Of the above appropriations $18,285.05 has been turned into the surplus fund of the Treasury.

Money statement.

July 1, 1887, amount available	$853.20
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	853.20
Amount appropriated by act of August 11, 1888	7,500.00
Amount (estimated) required for completion of existing project	8,100.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	8,100.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 4.

IMPROVEMENT OF DUCK CREEK, DELAWARE.

There were no operations during the fiscal year ending June 30, 1888, for want of funds.

The survey directed in the act of August 5, 1886, was completed and a report submitted and printed in the last Annual Report of the Chief of Engineers.

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The project recommended for the improvement is to give a 7-foot low-water navigation to the town of Smyrna, Del., the head of navigation. The channel at the entrance to be 100 feet wide and inside the creek 60 feet in width.

The estimated cost of the dredging is $37,365.20. To protect the channel at the entrance by the construction of a jetty would cost, built of wood, $20,000; made of stone, $53,333.20.

In case no jetty was built, $2,000 annually would probably be required to maintain the channel at the entrance.

Ten thousand dollars was expended in dredging a channel through the bar at the entrance to 8 feet at low water; for want of a protecting work it has filled up to 4½ feet. The citizens have spent $6,500 in dredging inside the creek.

The commerce of the stream is estimated to be between $2,000,000 and $3,000,000. The amount that can be profitably expended during the fiscal year ending June 30, 1890, is $33,000, and if appropriated, will be applied to dredging a channel inside the stream in accordance with the project submitted.

Duck Creek is in the collection district of Delaware; Wilmington is the nearest port of entry, and the revenue collected there during the last fiscal year is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	2,000

Money statement.

Amount appropriated by act of August 11, 1868	$10,000.00
Amount (estimated) required for completion of existing project	80,698.40
Amount that can be profitably expended in fiscal year ending June 30, 1890	37,365.20
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 5.

IMPROVEMENT OF SAINT JONES RIVER, DELAWARE.

At the close of last fiscal year work was in progress under a contract with the American Dredging Co., dated January 13, 1887, and under this contract dredging was continued during the fiscal year ending June 30, 1888, until the end of July, 1887, when operations were suspended on account of the near exhaustion of funds. The result of the work under the contract was the removal of 10,291 cubic yards of material, measured in place, the excavation of a channel 40 feet wide at bottom and 6 feet deep at low water from the old ship-yard, one-quarter mile below Dover, to that place, and enlarging the turning basin to 125 feet radius. Also widening the channel at eight sharp bends between Lebanon and Dover.

The dredge was then removed to the entrance, and a channel 40 feet wide and 6 feet deep at low water was excavated through the bar a distance of 2,400 feet. Of this distance the United States Government paid for dredging 1,050 feet—4,100 cubic yards by special agreement with the dredging company, at 12 cents per cubic yard. The remainder

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of the distance dredged over the bar was paid for by the citizens interested in the navigation of the river.

The banks of the river between Lebanon and Dover were cleared of overhanging trees during the months of October and November, 1887.

At this date there is a 4-foot low-water navigation through the entrance 40 feet wide, and from thence to Dover 6-foot low-water navigation, 40 feet in width.

It is proposed to apply the appropriation asked for the fiscal year ending June 30, 1890, to securing a 3-foot low-water navigation through the entrance by dredging and constructing a jetty to protect the channel.

Since the improvement of this river a steamer runs regularly between Dover and Philadelphia, and rates of freight between those places have been much reduced.

Before the improvement there was no steam-boat navigation on this river, and the railroad had no competition.

Freight on calves from Dover to Philadelphia has been reduced from 90 cents per head to 30 cents per head.

It is assumed other freights have been proportionally reduced.

By this improvement the business of Dover, valued at $2,000,000, is offered a competing route of transportation, besides the country bordering on the river, which depends upon hauling their produce many miles to the nearest depots.

Dover is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved March 3, 1881	$5,000
By act approved July 5, 1884	10,000
By act approved August 5, 1886	10,000

Money statement.

July 1, 1887, amount available		$2,245.86
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887		2,245.50
July 1, 1888, balance available		.36
Amount appropriated by act of August 11, 1888		15,000.00
Amount available for fiscal year ending June 30, 1889		15,000.36
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

H 6.

IMPROVEMENT OF MISSPILLION CREEK, DELAWARE.

There were no operations during the fiscal year ending June 30, 1888, for want of funds. The condition of the improvement is unknown.

The project adopted is to give a 6-foot low-water navigation, 40 feet in width from the mouth to the head of navigation, and a 4-foot low-water navigation at the entrance. The tide rises 4½ feet at the entrance and 2½ feet at Milford.

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As far as could be ascertained there has been no change in the commercial statistics since last annual report.

Misspillion Creek is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved March 3, 1879	$3,000
By act approved June 14, 1880	4,000
By act approved March 3, 1881	3,500
By act passed August 2, 1882	3,000

Money statement.

Amount appropriated by act of August 11, 1888	$3,500.00
Amount (estimated) required for completion of existing project	55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	3,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 7.

IMPROVEMENT OF BROADKILN RIVER, DELAWARE.

There were no operations during the fiscal year ending June 30, 1888. The condition of the improvement is unknown, although it is reported that the work done in 1885 has maintained itself. There has been no change in the commercial statistics since the last annual report.

The improvement is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved March 3, 1873	$10,000
By act approved June 14, 1880	5,000
By act approved March 3, 1881	5,000
By act passed August 2, 1882	5,000

Money statement.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for completion of existing project	21,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	21,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 8.

IMPROVEMENT OF INDIAN RIVER, DELAWARE.

There has been no work on this improvement since 1883 for want of funds; the last information respecting the work done was that the channel had filled up for want of protecting dike, and no benefit had been derived from the improvement.

As the work done effected no benefit the cost of the improvement will have to remain at the original estimate, $50,000, and if the work

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of improvement is continued the amount should be appropriated in one sum to secure any good. The project is to dredge a channel 80 feet wide and 4 feet deep at mean low water through "The Bulkhead," and thence straight to the inlet, protecting it by the construction of a dike on its northern side.

By the completion of the improvement will be offered a competing route of transportation to a large commerce, consisting of fruits, vegetables, and oysters, the perishable nature of which prevents their being shipped by water while so much uncertainty exists as to the time required to get to sea.

There are fifty saw-mills in operation along the banks of Indian River and tributaries, and produce annually 54,000,000 feet of lumber, valued at about $1,000,000. A greater portion of this is hauled from 1 to 5 miles to the nearest railroad station, owing to the difficulties in entering the Indian River from the ocean.

When the improvement of the inland water-way from Chincoteague Bay, Virginia, to Delaware Bay, at or near Lewes, Del., is completed to Indian River, the commerce dependent on Indian River Inlet will be greatly increased until the improvement is completed to Delaware Bay.

After the improvement of the inland water-way is completed a better outlet for Indian River will be had through the route into Delaware Bay than can be given through Indian River Inlet to the ocean.

Indian River is in the collection district of Delaware. The nearest port of entry is Wilmington, at which the revenue collected during the last fiscal year amounted to $6,654.74.

AMOUNT APPROPRIATED.

By act passed August 2, 1882 ..... $10,000

Money statement.

Amount (estimated) required for completion of existing project	$50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 9.

IMPROVEMENT OF INLAND WATER-WAY FROM CHINCOTEAGUE BAY, VIRGINIA, TO DELAWARE BAY, AT OR NEAR LEWES, DELAWARE.

The commissioners appointed by an act of the Delaware legislature, passed April 4, 1887, met in January, 1888, and made the awards for damages to the land owners by reason of the construction of the proposed water-way.

The papers were forwarded to the Attorney-General and the title to the lands were by him approved May 9, 1888, provided the awards have been paid by the State treasurer. Effort is being made to secure the proper evidence of payment.

The work will be advertised as soon as the question of payment is settled.

The amount asked for the fiscal year ending June 30, 1890, is $100,000, and if appropriated, will be applied to the improvement, in accordance with the approved project. By an improvement of 15 miles of the proposed route, 150 miles of navigable water will be rendered available, giving an outlet to 400 square miles of territory.

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The estimated amount of commerce interested in the improvement, and which will be afforded a competing route of transportation, is $1,795,000.

AMOUNT APPROPRIATED.

By act approved August 5, 1886	$18,750

Money statement.

July 1, 1887, amount available	$17,946.57
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	17.98
July 1, 1888, balance available	17,928.59
Amount appropriated by act of August 11, 1888	50,000.00
Amount available for fiscal year ending June 30, 1889	67,928.59
Amount (estimated) required for completion of existing project	281,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 10.

IMPROVEMENT OF THE SUSQUEHANNA RIVER ABOVE AND BELOW HAVRE DE GRACE, MARYLAND.

There were no operations during the fiscal year ending June 30, 1888, for want of funds.

The effect of the dredging at the shoal near Watson's Island has been very perceptible in lessening the tendency of the ice to gorge at this point.

There has been no work on the shoals between Specutia Island and Havre de Grace since the summer of 1885, and the condition of the channel is unknown. The amount that can be profitably expended in the fiscal year ending June 30, 1890, is $20,000, and if appropriated will be applied to attaining a 15-foot navigation below Havre de Grace, and continuing the work of cutting off the shoal at Watson's Island to prevent the dangerous ice gorges.

The commerce on the river consists of stone, ice, coal, lumber, and fruit. Estimated value $1,500,000.

Susquehanna River is in the collection district of Baltimore. Baltimore is the nearest port of entry, at which the amount of revenue collected for the fiscal year ending June 30, 1888, is $2,996,220.14.

AMOUNTS APPROPRIATED.

By act approved August 30, 1852	$10,000
By act approved June 23, 1866	26,400
By act approved July 11, 1870	12,000
By act approved June 14, 1880	28,000
By act approved March 3, 1881	15,000
By act passed August 2, 1882	25,000
By act approved July 5, 1884	20,000
By act approved August 5, 1886	6,000

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Money statement.

Amount appropriated by act of August 11, 1888	$10,000.00
Amount (estimated) required for annual dredging	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 11.

IMPROVEMENT OF CHESTER RIVER AT KENT ISLAND NARROWS, MARYLAND.

Nothing done at this locality since 1877.

Chester River is in the collection district of Baltimore, which is also the nearest port of entry, at which the revenue collected for the fiscal year ending June 30, 1888, is $2,996,220.14.

AMOUNTS APPROPRIATED.

By act approved March 3, 1873	$15,000
By act approved June 23, 1874	5,000
By act approved August 14, 1876	5,000
By act approved June 18, 1878	3,000

Money statement.

July 1, 1887, amount available	$2,500.00
July 1, 1888, balance available	2,500.00

H 12.

IMPROVEMENT OF CORSICA CREEK, MARYLAND.

There has been nothing done during the present fiscal year for want of funds.

The original project, which is to excavate a channel 100 feet in width at bottom and 8 feet in depth at low water, has been completed, except for a distance of 2,300 feet above Hooper's Landing, where the width has been made only to 50 feet.

The amount asked for the fiscal year ending June 30, 1890, if appropriated will be applied to increasing the width of the channel, from Hooper's Landing to a point 2,300 feet above, to 100 feet at bottom and making the depth 8 feet at mean low water.

The improved channel has been in constant use.

Corsica Creek is in the collection district of Baltimore. Baltimore is the nearest port of entry, at which the amount of revenue collected during the last fiscal year was $2,996,220.14.

Money statement.

July 1, 1887, amount available	$19.49
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	19.49
Amount appropriated by act of August 11, 1888	10,000.00

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H 13.

IMPROVEMENT OF CHOPTANK RIVER, MARYLAND.

The object of this improvement is to give an 8-foot low-water navigation to Greensborough, Md., by dredging. The work was commenced in 1881. At the close of the fiscal year ending June 30, 1885, a channel had been excavated to Greensborough 6 feet in depth at low water, varying in width from 47 feet to 75 feet. An examination of the channel was made in November, 1886, for 2¾ miles below Greensborough, and it was found to be considerably filled in by washing of the banks.

A contract was made after due advertisement with Mr. Thomas P. Morgan in December, 1886. Very little work had been accomplished under the contract at the close of the fiscal year ending June 30, 1887, and operations have continued during the present fiscal year under the same contract, several extensions to the time for completion having been granted. The result of the work under this contract with the appropriation of August 5, 1886, is as follows: Commencing at a point 13,450 feet below Greensborough and working towards that place, a channel 25 feet wide and 8.5 feet deep at low water was excavated 2,150 feet in length. From this point for a distance of 4,390 feet, a depth of 5 feet at low water was found. This reach was passed over to dredge where there was less draught and to extend the navigable channel to Greensborough. Commencing again at the upper end of the 5-foot reach, a channel 25 feet in width and 8.5 feet deep at low water was excavated 568 feet; from thence to Greensborough, 6,342 feet, the channel was excavated 40 feet wide and 7 feet deep at low water, and at Greensborough a turning-basin 125 feet long and 100 feet wide in addition to the channel width was excavated. There being a small balance of the appropriation available after completion of the turning-basin, the dredge was removed downs-tream to the 5-foot draught, and a cut 40 feet wide and 7 feet deep at low water excavated 694 feet down-stream.

The material removed from the 40-foot channel proved too hard for the first dredge put on the work, and another and larger one had to be furnished, and the increase in width was necessary to float this dredge, and the reduction in depth had then to be made to extend the work to Greensborough.

The total amount of material removed is 45,220 cubic yards.

The material from the 25-foot cuts was deposited by a shute 80 feet from the edge, and from the 40-foot cut by a long boom behind the old dredge bank.

Operations were suspended in May, 1888, owing to near exhaustion of funds. An examination was made of the river in June, 1888, from Greensborough to within 3,150 feet of Denton, and the following is the present condition: With the exception of three shoals, over which there is 6 feet of water, one 1,100 feet long, 3,200 feet above the bridge at Denton; one 750 feet long, 8,200 feet above the same place, and one 1,250 feet in length, 15,650 above the same place; there is an 8-foot low-water navigation 18,200 feet above Denton. From this point a reach extends 3,700 feet, with an average depth of 5½ feet at low water. Brick Mill Landing is at this shoal, and is 20,500 feet above the bridge at Denton; from thence, for a distance of 4,000 feet, there is an 8-foot low-water navigation; from thence to Case's Wharf, at Greensborough, excepting five shoals, with an aggregate length of 2,500 feet, over which there is but 5 feet of water, there is a 7-foot low-water navigation.

Originally the depth of water between Denton and Greensborough

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varied from 2 feet to 8 feet at low tide. A full description of the river before the improvement was commenced is given in the Annual Report of the Chief of Engineers for 1880, pages 634, 635.

The amount asked for the fiscal year ending June 30, 1890, if appropriated, will be applied to dredging in accordance with approved project to secure an 8-foot navigation to Greensborough.

Since the improvement a steamer runs direct to Greensborough from Baltimore, and another from Greensborough to Denton connecting with the Maryland Steamboat Company from Baltimore. There are also four 100-ton schooners and a number of smaller ones, which run to Greensborough from Baltimore, Philadelphia, and New York. The large vessels when loaded have to continue the use of lighters. The estimated value of the commerce on the river is about $800,000. The estimated value saved to the community by completion of the improvement is $54,000 annually.

Choptank River is in the collection district of Baltimore. Baltimore is the nearest port of entry, at which the amount of revenue collected for the fiscal year ending June 30, 1888, is $2,996,220.14.

Money statement.

July 1, 1887, amount available	$8,849.97
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,849.97
Amount appropriated by act of August 11, 1888	7,500.00
Amount (estimated) required for completion of existing project	39,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

H 14.

IMPROVEMENT OF NANTICOKE RIVER, DELAWARE.

At the close of last fiscal year work was in progress under a contract with Frank C. Somers, dated January 14, 1887, and under the same contract continued in the fiscal year ending June 30, 1888, to February 19. Little had been accomplished at the end of last fiscal year.

The following is the result of the work with the appropriation of August 5, 1886 ($10,000):

Several shoals were removed from the turning-basin at Laurel, and from thence to the Delaware Railroad Bridge, a distance of 1,950 feet, a channel was excavated 45 feet in width and 5 feet in depth at low water. At the county bridge the width was increased to 70 feet for a length of 200 feet, to make available both draw-spans in the bridge.

From the Delaware Railroad Bridge to a point 12,350 feet downstream, where the 7-foot curve is intersected, the channel was excavated to a width of 50 feet and 6 feet in depth, at mean low water, and three bends increased in width to 60, 70, and 60 feet, respectively. A cut was also made through Collins' Bar, about one-half mile further downstream, 600 feet in length, 50 feet wide, and 6 feet deep at mean low water.

The total distance dredged is 14,900 feet. The total amount of material removed is 61,747 cubic yards.

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The citizens of Laurel also expended between $12,000 and $13,000 in construction of wharves and dredging in front of them.

Originally, the portion of the river improved was navigable for lighters only. There is now a 6-foot low-water navigation to the Delaware Railroad Bridge, and from thence to the turning-basin a 5-foot low-water navigation.

The estimates for further improvement and commercial statistics, see under head of Improvement of Broad Creek, Delaware, of these reports.

Money statement.

July 1, 1887, amount available	$8,939.09
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1887	8,939.09

For balance of statement, see money statement for Broad Creek, Delaware.

H 15.

IMPROVEMENT OF BROAD CREEK FROM ITS MOUTH TO LAUREL, DELAWARE.

The act approved August 5, 1886, appropriated $10,000 for "Improving Nanticoke River, Delaware, continuing the improvement up to and near the town of Laurel, Del.," and under the head of "Improvement of Nanticoke River, Delaware," is stated the condition of the work and the progress made during the fiscal year ending June 30, 1888.

The amount that can be profitably expended during the fiscal year ending June 30, 1890, is $10,000, and, if appropriated, will be applied to increasing the width and depth to 50 feet and 7 feet, respectively.

Congress has passed an act requiring the Delaware Railroad Company to place a draw in its bridge at Laurel, which, when completed, will be a great advantage to navigation by permitting all vessels to reach the turning-basin.

There has been no change in the commercial statistics since the last annual report, but the facilities for navigation have been greatly increased.

Broad Creek is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the fiscal year ending June 30, 1888, is $6,654.74.

AMOUNTS APPROPRIATED.

By act approved June, 14, 1880	$5,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	5,000
By act approved August 5, 1886	10,000

Money statement.

Amount appropriated by act of August 11, 1888	$5,000.00
Amount (estimated) required for completion of existing project	27,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1890	10,000.00

Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.

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H 16.

IMPROVEMENT OF WICOMICO RIVER, MARYLAND.

There were no operations during the fiscal year ending June 30, 1888. There has been no work since 1885, at which time the project was completed. The Channel has been in constant use.

Full commercial statistics and the benefits to commerce and navigation were given in last annual report. There has been no changes since then.

Wicomico River is in the collection district of the eastern district of Maryland. Crisfield is the nearest port of entry, at which the amount of revenue collected during the last fiscal year is $———.

AMOUNTS APPROPRIATED.

By act approved—	
June 10, 1872	$5,000
March 3, 1873	5,000
June 24, 1874	5,000
March 3, 1875	5,000
August 14, 1876	5,000
June 18, 1878	5,000
March 3, 1879	3,000
June 14, 1880	5,000
March 3, 1881	2,000
July 5, 1884	10.000

Money statement.

July 1, 1887, amount available	$1,372.80
July 1, 1888, balance available	1,372.80

H. 17.

IMPROVEMENT OF UPPER THOROUGHFARE, BETWEEN DEIL'S ISLAND AND THE MAINLAND, MARYLAND.

There has been no work at this locality during the fiscal year, the money available being inadequate to commence operations.

The project is to dredge a basin with an approach to deep water and construct a breakwater to protect it from filling, the object being to provide a harbor of refuge for small vessels, and a place at which steamers can stop and bring the people and their abundant crops, from land and water, into quick communication with the markets of Baltimore and Philadelphia.

This improvement is in the collection district of the eastern district of Maryland Crisfield is the nearest port of entry. The amount of revenue collected there for the last fiscal year is $———.

AMOUNT APPROPRIATED.

By act passed August 2, 1882	$5,000

Money statement.

July 1, 1887, amount available	$4,669.91
July 1, 1888, balance available	4,669.91

Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30,1890	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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H 18.

IMPROVEMENT OF POCOMOKE RIVER, MARYLAND.

A survey was made of this river in 1884 and the project for improvement submitted contemplated making a cut-off through the low neck of land forming four abrupt bends just below Snow Hill, Md., which rendered navigation both difficult and dangerous.

The channel to be 80 feet wide and 7 feet deep at mean low water. The cut-off to be 1,100 feet in length. The right of way was given the United States free of cost. The work was advertised in August, 1887, and a contract was made with the Atlas Dredging Company, the lowest bidder.

Owing to ice and extreme cold weather the contractor was unable to commence work before the spring of 1888. The contract price being much less than the estimate, it was recommended and approved to apply the balance of the available funds to the removal of seven shoals below the cut-off and excavating a turning-basin at Snow Hill.

The work was begun in April, 1888, and completed by the end of the fiscal year. In accordance with the above project 53,386 cubic yards of material were removed. There is now a good 7-foot low-water navigation to Snow Hill, the head of navigation.

Pocomoke River is in the eastern district of Maryland. Crisfield is the nearest port of entry, at which the amount of revenue collected during the last fiscal year is $——

AMOUNTS APPROPRIATED.

By act approved—	
June 18, 1878	$10,000
March 3, 1879	2,500
August 5, 1886	8,000

Money statement.

July 1, 1887, amount available		$8,000.00
July 1, 1888, amount expended during fiscal year, exclusive of liabilities outstanding July 1 1887	$4,132.41	
July 1, 1888, outstanding liabilities	2,645.10	
		6,777.51
July 1, 1888, balance available		1,222.49

Abstract of proposals received and opened September 28, 1887, at 12 o'clock noon, by General William F. Smith, United States agent, for dredging in Pocomoke River, Maryland.

No.	Names and addresses.	Time.		Price per cubic yard, place measurement.
		Commence.	Complete.	
				Cents.
1	George W. Parsons, Salisbury, Md			22
2	National Dredging Company, Wilmington, Del	In 30 days.	Prosecute with vigor until completed.	16½
3	American Dredging Company, Philadelphia, Pa	Dec. 1, 1887	Feb. 1, 1888	11
4	Frank C. Somers, Philadelphia, Pa	Dec. 15, 1887	June 15, 1888	16
5	Atlas Dredging Company, Wilmington, Del	Dec. 1, 1887	May 1, 1888	10

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H 19.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

At the close of the last fiscal year a contract had been made with Mr. Edward T. Veasey, of Lewes, Del., under provision of section 4 of the act of June 14, 1880, for the removal of the wreck of the steam propeller *J. I. Van Doren* from the Broadkiln River, Delaware.

The work was begun promptly and completed by the 20th of July, 1887, at a total cost of $242.13.

The wreck was of no value.

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